

IMP. BUREAU ENTOM.

ed. 2 OCT. 1913

151.

University of Maine.

EXAMIN

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 212

MARCH, 1913

ORCHARD SPRAYING EXPERIMENTS IN 1912

CONTENTS.

The 1912 Experiments with Fungicides	61
Discussion of Results	67
Experiments with Different Arsenicals	70
Discussion of Results	72

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	President
DIRECTOR CHARLES D. WOODS,	Secretary
CHARLES L. JONES, Corinna,	}
FREELAND JONES, Bangor,	
JOHN M. OAK, Bangor,	
JOHN A. ROBERTS, Norway	
EUGENE H. LIBBY, Auburn,	Committee of Board of Trustees
ROBERT H. GARDINER, Gardiner,	Commissioner of Agriculture
RUTILLUS ALDEN, Winthrop,	State Grange
WILLIAM H. DAVIS, Augusta, Maine	State Pomological Society
LIVESTOCK BREEDERS' ASSOCIATION	State Dairymen's Association
WILLIAM G. HUNTON, Readfield,	Maine Livestock Breeders' Association
	Maine Seed Improvement Association

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS.

THE STATION STAFF.

ADMINIS- TRATION	CHARLES D. WOODS, Sc. D.,	Director
	BLANCHE F. POOLER,	Clerk
	GEM M. COOMBS,	Stenographer
	JANIE LOGIE FAYLE,	Stenographer
BIOLOGY	RAYMOND PEARL, Ph. D.,	Biologist
	MAYNIE R. CURTIS, A. M.,	Assistant
	CLARENCE W. BARBER, B. S.,	Assistant
	WALTER ANDERSON,	Poultryman
	ESTELLA MORRISON,	Computer
CHEMISTRY	JAMES M. BARTLETT, M. S.,	Chemist
	HERMAN H. HANSON, M. S.,	Associate
	EDWARD E. SAWYER, B. S.,	Assistant
	HELEN W. AVERILL, B. S.,	Assistant
	ELMER R. TOBEY, B. S.,	Assistant
ENTOMOL- OGY	HARRY C. ALEXANDER,	Laboratory Assistant
	EDITH M. PATCH, Ph. D.,	Entomologist
	ALICE W. AVERILL,	Laboratory Assistant
PLANT PATHOLOGY	WARNER J. MORSE, Ph. D.,	Pathologist
	CHARLES E. LEWIS, Ph. D.,	Associate
	MICHAEL SHAPOVALOV, B. A.,	Assistant
	VERNON FOLSOM,	Laboratory Assistant
HIGHMOOR FARM	WELLINGTON SINCLAIR,	Superintendent
	GEORGE A. YEATON,	Orchardist
ROYDEN L. HAMMOND,	Seed Analyst and Photographer	
CHARLES S. INMAN,	Assistant	

BULLETIN No. 212.

ORCHARD SPRAYING EXPERIMENTS IN 1912.

W. J. MORSE AND G. A. YEATON.

At this Station the first tests of lime-sulphur as a substitute for bordeaux mixture in spraying apple orchards was made in 1908. This was an experiment planned and conducted by the Department of Plant Pathology, the results being reported in Bulletin 164. In this work self-boiled lime-sulphur was prepared by using both hot and cold water and was compared with bordeaux mixture to test its efficiency in the control of apple scab. Five varieties of apples were used, including the Fameuse and the McIntosh, both of which are quite susceptible to scab.

Although three applications of the sprays were made, the first when the leaves were unfolding, the second just after the petals fell, and the third about three weeks later, considerable scab developed on all of the sprayed trees. While the results from the self-boiled lime-sulphur showed that it had materially reduced the amount of scab the bordeaux mixture showed much more efficient control of the disease. However the test was a severe one and 99 per cent of the apples on the unsprayed trees were scabbed.

The same experiment was repeated in 1909 in the same orchard but, on account of weather conditions, that season scab failed to develop even on the unsprayed trees, consequently the results were inconclusive and were not written up for publication. Neither in 1908 nor in 1909 was there any spray injury to be observed on foliage or fruit, even where the bordeaux mixture was used.

Highmoor Farm came under the management of the Maine Agricultural Experiment Station on July 1, 1909, and the orchards, which now consist of over 2300 trees, furnished the

Station for the first time in its history an opportunity to make spraying experiments on a large scale in an orchard entirely under its control. By this time the results of experiments made in other parts of the country indicated that a concentrated mixture of lime and sulphur in water, cooked by artificial heat and then diluted before applying, was the most promising lime-sulphur spray for apple orchards. It was claimed to be more effective than the self-boiled article and entirely free from spray injury, thus, in this respect, being much superior to bordeaux mixture.

Therefore an experiment was planned for 1910 as one of the plant pathology projects for that year in which it was proposed to test the value of artificially boiled or cooked lime-sulphur as an orchard spray, as compared with the self-boiled and with bordeaux mixture. Also it was planned to test the relative efficiency of several commercial brands of concentrated, boiled lime-sulphur as compared with the home-cooked article. With the appointment of Mr. W. W. Bonns as Station Horticulturalist, stationed at Highmoor Farm, the project was transferred to his department. Mr. Bonns carried on two series of experiments, one in 1910 and one in 1911, the results of which were quite fully reported in Bulletins 189 and 198. In the first publication, in addition to giving an account of the results of the experimental work of the season, he reviewed in considerable detail the literature upon the use of lime-sulphur as a summer spray, the use of sulphur and its compounds as fungicides, the question of spray injury from bordeaux mixture, etc. On account of the great demand for Bulletin 189 it was soon out of print. Therefore a summary of the experimental results obtained in 1910 were included in Bulletin 198 with those obtained in 1911.

The apple orchards at Highmoor Farm consist almost entirely of the Ben Davis and Baldwin varieties. The entire orchards were sprayed once late in June 1909 with bordeaux mixture and arsenate of lead, largely to control leaf-eating insects, just as soon as it was found that the purchasing committee had decided to buy this farm. So far as known this was the first time the trees, which were then in a much neglected, half-starved condition, had ever been sprayed. In 1910 all but the experimental plots received three applications of bordeaux mixture and arse-

nate of lead. During both seasons much damage from spray injury resulted to both foliage and fruit, particularly on the Ben Davis. Since 1910 the main orchards have been sprayed yearly with home-cooked lime-sulphur and with uniform success as far as spray injury was concerned.

On account of weather conditions no real severe test of lime-sulphur as a means of control of apple scab was experienced until the present year, although the data secured in 1910 were sufficiently conclusive for practical purposes with regard to certain questions under consideration. The artificially cooked lime-sulphur gave that year, as a rule, much better results as to scab control than did the self-boiled article. The results in 1910 were also slightly in its favor in this respect when compared with bordeaux mixture. The commercial brands of concentrated lime-sulphur were, during that season, somewhat more effective than the home-cooked material, but this advantage was not considered sufficient to offset the greater cost of the former for large orchards.

With regard to injury to foliage and fruit all of the lime-sulphur sprays proved to be much more satisfactory than bordeaux mixture, although one proprietary spray, the name of which indicated that it was some sort of a sulphur compound, produced much greater spray injury than did bordeaux mixture. However, in these orchards of over 2300 trees, mostly Ben Davis and Baldwin, wherever bordeaux mixture has been used during the past four years the resulting injury to foliage and fruit has, as a rule, more than offset the benefits derived from fungus control. It will be seen later that during 1912, while the foliage escaped, much russetting was produced on the fruit. On the other hand, properly made and properly applied lime-sulphur has produced practically no foliage injury and very little russetting of the fruit could be attributed to it. At the same time when applied at the proper time, particularly in the experiments to be described in this bulletin, it was quite effective in the control of the apple scab fungus on both foliage and fruit.

While it has been shown conclusively in these experiments and those conducted elsewhere that lime-sulphur is a much safer spray to use on those varieties of apples like the Ben Davis which are very susceptible to spray injury, there are certain varieties of apples which are not injured or are but slightly

injured by bordeaux mixture. Moreover the work of Stewart and his associates of the New York Station has shown that lime-sulphur not only is far inferior to bordeaux mixture as an agent to control the late blight and other potato leaf-diseases, but it is apparently positively detrimental to the potato.* Therefore it seemed justifiable to plan a series of experiments extending over a number of years in which the relative efficiency of bordeaux mixture and lime-sulphur as a spray for apple orchards could be tested under a variety of seasonal weather conditions. While the reports are everywhere quite favorable to lime-sulphur, as an orchard spray the data so far accumulated are not sufficiently varied and complete to draw final conclusions. If bordeaux mixture is more effective or even equally effective in scab control there is no reason for the orchardist who experiences no injury from it upon the varieties which he grows to discard it in favor of lime-sulphur.

Certain writers, a summary of whose work Mr. Bonns gave in Bulletin 198 have noted the fungicidal value of lead arsenate.[†] Therefore the experiments for 1911 were so planned as to include a test of the fungicidal value of lead arsenate, further comparisons of the fungicidal value of bordeaux mixture and home-cooked lime-sulphur, and a test of different dilutions of lime-sulphur to determine which is the most satisfactory strength to use, both with regard to control of scab and freedom from spray injury. The variety used for making these tests in all cases being the Ben Davis.

On account of weather conditions being unfavorable to the growth of the fungus practically no scab developed in the orchards in 1911 so that from that standpoint no data of value was secured. In fact on account of the failure of scab to develop the only clear-cut result of the experimental spraying of that year was with regards russetting the fruit. Where bordeaux

* Stewart, F. C. and French, G. T., Lime-Sulphur vs. Bordeaux Mixture as a Spray for Potatoes. Bul. N. Y. Agr. Exp. Sta. 347, 1911. Munn, M. T., Lime Sulphur vs. Bordeaux Mixture as a Spray for Potatoes II. Bul. N. Y. Agr. Exp. Sta. 352, 1912.

† Taylor, E. P., Spraying Peaches for Brown Rot, Western Fruit Grower, pp. 20-21, Oct. 1909, pp. 16-18, Feb. 1910.

Wait, M. B. Experiments on the Apple with Some New and Little Known Fungicides, Cir. U. S. D. A. Bu. Pl. Ind. 58, 1910.

Wallace, E., Blodgett, F. M. and Hessler, L. R. Studies of the Fungicidal Value of Lime Sulphur. Bul. Cornell Agr. Exp. Sta. 290, 1911.

mixture was used over 70 per cent of the apples were so affected while on the other plots this was not over 2 per cent in any case and the amount was fairly uniform, regardless of the kind and strength of the spray.

THE 1912 EXPERIMENTS.

In 1912 the apple spraying experiments were again transferred to the Department of Plant Pathology. When the first two applications of the spray were applied in the experiments which will be described the Station pathologist was on a leave of absence, otherwise an unsprayed check-plot would have been saved for comparison. That part of the work which was primarily concerned with the fungicidal value of the different sprays was an exact duplicate of that carried out the season before, but as has already been pointed out the weather conditions of the summer of 1912 were much more favorable to the test.

In this experiment there were used 139 Ben Davis trees, about twenty-five years old and which constituted a block at one corner of the most thrifty orchard on the farm. This is the same block of trees which was used in 1910 and 1911 experiments. Previous to 1909 this orchard, like the others on the farm, had been much neglected, although it showed some evidence of previous cultivation and had also been used for a sheep pasture in recent years. For the past three years it has been well fertilized and has been thoroughly cultivated each year. It is now in a quite thrifty condition. The block was divided into six different plots.

Plot A was sprayed with arsenate of lead 4 pounds in 50 gallons of water.

Plot B was sprayed with home-cooked lime-sulphur, 27° Beaumé density 2 gallons, in water sufficient to make 50 gallons. This was called the "one-fifth stronger" plot as the spray carried 20 per cent more of the concentrate than is commonly recommended.

Plot C or the "standard dilution" plot was sprayed with 1 2-3 gallons of the same lime-sulphur concentrate, diluted with water to make 50 gallons. This is the same dilution as is used on the general orchards on the farm.

Plot D was called the "one-fourth weaker" plot as only 1 1-4 gallons or 25 per cent less of the concentrate than in Plot C was used to each 50 gallons of the spray.

Plot E was sprayed with 2 pounds of arsenate of lead in 50 gallons of water.

Plot F was sprayed with a 3-3-50 bordeaux mixture.

Two pounds of arsenate of lead were added to the spray in each case on plots B, C, D and F. All of the sprays were applied with a gasoline power sprayer outfit, using two leads of hose at a time at about 150 pounds pressure. Care was taken to thoroughly wash out both the tank and the pump after using each different kind of spray, before putting in the next. The relative position of the plots and the number of trees in each are best shown in the following plan.

PLAN OF EXPERIMENT.

	A	B	C	D	E	F
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0

- A. 9 trees, arsenate of lead 4 lbs. to 50 gallons.
- B. 35 trees, lime-sulphur 2 gallons in 50, 2 lbs. arsenate of lead.
- C. 36 trees, lime-sulphur $1\frac{1}{2}$ gallons in 50, 2 lbs. arsenate of lead.
- D. 35 trees, lime-sulphur $1\frac{1}{4}$ gallons in 50, 2 lbs. arsenate of lead.
- E. 12 trees, arsenate of lead 2 lbs. to 50 gallons.
- F. 12 trees, 3-3-50 bordeaux mixture, 2 lbs. arsenate of lead.

As originally planned three applications of the sprays were to be made, the first just as the blossoms were showing pink, the second after the petals fell and the third about three weeks later. The early part of the season was very wet and for several days before the first application should have been made it rained almost constantly. Partly on this account and partly on account of a misunderstanding on the part of those in charge of the work at that time the first application of the sprays on the experimental plots was delayed so long that the blossoms opened before it could be applied. Fortunately, on the orchard adjoining the plot, where exactly similar conditions existed with regards soil, age, variety and condition of the trees, this first application was made just before the blossoms opened. Hence this furnished opportunity to select a plot of trees sprayed three

times with standard dilution lime-sulphur and where the applications were made at the proper dates as was intended in the original experiment. As will be seen later the results from this block of trees furnished an excellent demonstration, when compared with the other experimental plots, of the value of a fungicidal spray for apple scab when applied just before the blossoms open. This plot will be referred to as Plot G.

Plots A to F inclusive were sprayed first on June 5 and again on July 1. Plot G was sprayed on May 24, June 5 and July 1.

EFFECT OF THE SPRAYS ON THE FOLIAGE.

The experimental plots were under the constant observation of the orchardist, Mr. Yeaton, and were frequently visited by Dr. Lewis, the associate pathologist, and the writer during the season.

On June 5 there was no evidence of scab in any of the orchards. On plot G where the first application of lime-sulphur was made on May 24 there was no evidence of spray injury although an occasional leaf showed scorching at the margin.

Plot A, 4 pounds of arsenate of lead with no fungicide, showed a small amount of scab on the leaves of all of the trees, some leaves being quite badly affected on the first of July. No spray injury was noted at that time. By the middle of July the scab had not developed much more but there was by this time abundance of spray injury on the leaves. By August first the foliage still plainly showed the effects of spray injury but the evidences of scab on the leaves had largely disappeared. A record was also kept on the appearance and development of scab on the fruit on this and other plots but this will be discussed under another heading.

Plot B, sprayed with 2 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons, showed a quite general infestation of scab on the leaves by July 1. However, while some of the leaves on all of the trees in this plot were attacked, the infestation was, on the whole, recorded as slight as compared with plots C. D. and E. By the middle of July there was not much evidence of farther development of scab, but some

spray injury was plainly evident on the foliage. This was, however, frequently plainly associated with scab spots and suggested that it might be analogous to arsenical injury on potato leaves which have been injured by flea beetles. A given amount of Paris green or other arsenical may be used on potato plants with perfect safety so long as the epidermis of the leaves is unbroken. On the other hand, if a considerable number of flea-beetle punctures are present in the leaves arsenical injury is quite likely to result, the severity of the injury varying with the number of punctures.

By August 1 the evidence of scab infestation on this plot had largely disappeared and no increase of the amount of spray injury on the foliage was observed during the remainder of the season.

Plot C sprayed with 1 2-3 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Detailed records made of the amount of scab on the leaves of the individual trees in this plot at various times during the season showed relatively more scab was present than on plot B, where the "one-fifth stronger" dilution of lime-sulphur was used. On the other hand very little leaf-spot or spray injury was observed on plot C.

Plot D, sprayed with 1 1-4 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Much more scab was observed on this than on any of the other lime-sulphur plots. Judging from the appearance of the leaves alone, and in comparison with plot E the two applications of this weaker dilution of lime-sulphur failed to exert any restraining influence on the development of the scab fungus whatever, although it will show later that it did reduce somewhat the amount of scab on the fruit.

Plot E, sprayed with 2 pounds of arsenate of lead in 50 gallons of water. With the exception of plot D this showed the greatest development of scab on the foliage of any. In this connection it should be noted that there was a decidedly less amount of scab on the leaves of the trees in plot A where double the amount of arsenate of lead was used without any lime-sulphur. In fact on the last mentioned, considering plot E as a check, the control of scab on the foliage was fully equal to that

on the "standard dilution" plot and nearly equal to that on the "one-fifth stronger" plot.

Plot F, sprayed with a 3-3-50 bordeaux mixture. During the present season if final conclusions were to be based on the effects on the leaves alone bordeaux mixture showed much better results than lime-sulphur. However the final record of the percentages of perfect and imperfect fruit, which are given later, tell a somewhat different story. On plot F, where bordeaux mixture and arsenate of lead was used there was almost perfect control of scab on the foliage and no spray injury of the leaves was observed. On the other hand very severe spray injury to the leaves was experienced on the same variety in previous years.

Plot G, sprayed with "standard dilution" lime-sulphur the same as plot C, except that it received an application on May 24, just before the flower buds opened. On this plot throughout the season the control of scab on the leaves was all that could be asked for, and little or no spray injury was apparent.

EFFECT OF THE SPRAYS ON THE FRUIT.

Notes and observations were made and records kept of the development of scab and the appearance of russetting on the fruit during the season. These records do not give any additional information which is of material value and which is not indicated by the condition of the fruit at the time of harvesting, therefore they are omitted.

The fruit on the trees on the experimental plots under consideration averaged about 3 barrels per tree, giving on the entire area over 400 barrels. So far as could be observed the condition of the fruit on the different trees in each plot was fairly uniform, therefore it seemed to be an unnecessary expenditure of time and labor to attempt to sort and count the entire quantity. For the purpose of obtaining the necessary data the entire crop on 6 trees in each plot was picked separately, placed in barrels and taken to the packing shed for sorting. In all plots except A, E, and F, where this was impossible, the 6 trees constituted one of the rows nearest the center of the plot. The amount of fruit actually used and counted to obtain the data

recorded in the following table amounted to about 20 barrels per plot or treatment. In some cases it ran over this and in others, notably in plot G, it was somewhat less than 20 barrels.

It will be noted in the table that in plot E the percentages total slightly more than 100 while in plot F they amount to considerably more than this. This is accounted for by the fact that in some cases, particularly in plot F the same apples were both scabbed and russeted.

RESULTS OF THE FUNGICIDE EXPERIMENTS ON THE FRUIT.

Plot.	TREATMENT.	Total No. of apples.			Number russeted.	*Per cent. of perfect apples.	*Per cent. of scabby apples.	*Per cent. of russeted apples.
			Number smooth.	Number scabby.				
A	Arsenate of lead 4 lbs.—water 50 gallons.....	10,507	7,132	2,660	715	67.8	25.3	6.8
B	Lime-sulphur 2 gals.—arsenate of lead 2 lbs.—water 48 gals.....	10,298	7,409	2,520	369	71.8	24.4	3.5
C	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.	9,312	4,727	4,439	146	50.7	47.6	1.5
D	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.	9,513	3,450	5,835	228	36.2	60.9	2.3
E	Arsenate of lead 2 lbs.—water 50 gals.....	9,935	1,859	8,044	52	18.7	80.6	2.3
F	Bordeaux mixture 3-3-50—arsenate of lead 2 lbs.....	9,363	5,959	3,048	3,404	63.6	32.5	35.3
G	Lime-sulphur 1½ gals.—arsenate of lead 2 lbs.—water 48½ gals.†	6,733	5,985	95	650	88.8	1.4	9.6

* The per cents. do not total 100 as in some instances a considerable number of the same apples were both scabby and russeted.

† Like plot C except that an application was made just before the flower buds opened.

DISCUSSION OF RESULTS.

As has already been mentioned the original plan of the experiment called for an application of the various sprays when the flower buds began to show pink, or before they opened. The failure to do this greatly lessened the value of the data which it was planned to obtain. Fortunately, however, this omitted spray was applied to the adjoining orchard from which plot G was taken. As a result certain other data were obtained which are doubtless of more practical value than that originally desired.

Efficiency of the first spray application. Perhaps the most striking thing about the results secured is with regards the value of the spray applied before the blossoms opened as compared with the two following applications. This is shown by the figures obtained on plots C and G. The treatment on these two plots being exactly alike except that on C the first spraying was omitted. In one case only about 50 per cent of perfect apples were obtained and nearly all of the remainder of the fruit was scabbed. In the other nearly 90 per cent of the fruit was sound and perfect and less than 1.5 per cent was scabby. It is true that on the last plot nearly 10 per cent were classed as russeted but this figure is somewhat misleading as the russetting was, as a rule, very slight. Very few of these so-called russeted apples would have to be sold for less than a No. 2 grade.

The general conclusion was that, under the existing weather conditions of the past season, where the first spraying was omitted the profits derived from the two following sprayings paid little more than the cost of application. This statement should not be taken as implying that these are not important or advising that they should be omitted, but as pointing out the great importance of the first spraying, applied at the proper time. The more complete knowledge of the life history of the scab fungus which has been gained in recent years coincides with these experimental results.

The fungus passes the winter on fallen leaves under the trees. In early spring on these leaves of the season before it matures within a capsule an entirely different type of spore from that which leads to the propagation and spread of the fungus during the following summer. These sac spores are thrown out in the

spring in large numbers, are carried to the leaves of the lower branches of the trees, and there serve as centers of infection as soon as they have germinated and have begun to produce a diseased area. This period of ejection of the sac spores lasts but for a comparatively short time and then the danger from them is largely past. Consequently if a fungicidal spray is applied to the trees when these spores are being matured and thrown off, or at least before they have germinated and infected the leaves and parts of the young blossom buds, a large proportion of the potential possibilities of scab infestation for the coming season will be eliminated at the start. If, on the other hand, the first application is too long delayed and infection has occurred no amount of later spraying will absolutely control the disease although it may do much to prevent its spread to uninjected fruit and leaves.

That two applications of standard dilution lime-sulphur did materially check the development of scab is plainly shown in comparing plots C and E where the former gave 32 per cent more perfect apples than the latter. On the other-hand plot G, sprayed three times, gave a like increase of over 70 per cent. This much greater efficiency in disease control is very evidently due to the prevention of the early spring infection from the sac spores produced on the old leaves under the trees.

Dilution of lime-sulphur. The fact that only two applications were made to the different plots of which the different dilutions of lime-sulphur were tested detracts from the value of the data obtained. While too sweeping conclusions should not be drawn from them, the results taken for their face value are fairly suggestive. The "one-fifth stronger" dilution was decidedly more efficient in scab control than was the "standard dilution" and produced but little more russetting of the fruit. This did, as has been previously noted, produce some slight leaf injury. Judging from this season's experience and that of the year before it would seem that a 27° Baumé lime-sulphur can be used at the rate of two gallons to 48 of water with comparative safety on varieties like the Ben Davis which are very susceptible to spray injury. Judging from the results of the present season alone this stronger dilution is much more efficient than the standard dilution in scab control—possibly sufficiently so to

warrant its use in commercial spraying. However this is a matter which requires more confirmatory evidence.

The "one-fourth weaker" dilution on plot D proved to be entirely inefficient in scab control and doubtless what gains there were did not pay the cost of spraying. While it is very likely that much better results would have been obtained if another application of this spray had been made earlier it is not felt that the results are sufficiently encouraging to warrant following it farther another year.

Lime-sulphur vs. bordeaux mixture. The percentage of perfect apples obtained from the plot sprayed with bordeaux mixture exceeded that produced on those plots sprayed with lime-sulphur the same number of times with the exception of plot B where the strongest lime-sulphur spray was used. Here again, however, the figures do not tell the whole story. Strange as it may seem, practically all of the scabbed apples on the bordeaux sprayed plot were also among the russeted. However, very few of the apples on this plot were very badly affected with scab. On the other hand the scabbed apples on the lime-sulphur sprayed plots were, as a rule, somewhat more seriously affected. While the slightly scabbed apples on the bordeaux plot would doubtless keep in storage better than the slightly more severely attacked fruit on the lime sulphur plots the latter fruit on account of its freedom from spray injury or russetting would bring a higher market price.

Arsenate of lead as a fungicide. Another very striking fact in connection with results obtained was the apparent effectiveness of heavy applications of arsenate of lead in the control of apple scab as is shown by a comparison of the per cent of scabby apples recorded from plots A and E. In one case where 4 pounds of arsenate of lead to 50 gallons of water was used with no other material added as a fungicide only a little over 25 per cent of the fruit was scabbed while in the other case where only half as much arsenate of lead was applied over 80 per cent of the apples were scabby. Moreover it will be seen on reference to the table that where the 4 pounds of arsenate of lead was used alone the percentage of perfect apples obtained was greater than on all other plots which received the same number of applications except B, where the stronger dilution of lime-sulphur was used.

DISCUSSION OF RESULTS.

The results set forth in the above table are so self-evident that very little discussion is necessary. It will be seen that with regards insect control the three different insecticides produced almost exactly identical results. It may be said in this connection that not one of the apples classed as "wormy" was attacked by the codlin-moth but by the lesser apple worm. It will also be seen on comparing the per cents of sound fruit that the two substitutes produced even better results with regard to russetting than did the arsenate of lead paste, although these differences are probably within the limits of experimental error. So far as can be judged from the data obtained by this one experiment dry arsenate of lead and arsenate of zinc are fully as effective and are as safe to use as arsenate of lead paste. The results of the experiment, were on the whole so satisfactory, both with regards insect control and ease in mixing with the spray liquid, that dry arsenate of lead will be used on all the orchards at Highmoor Farm in 1913.

Rec'd. 20 Oct. 1913

Ans.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 213

JUNE, 1913

APHID PESTS OF MAINE II. WILLOW FAMILY

CONTENTS.

This bulletin contains a descriptive account of Maine aphides infesting the plants of the willow family, accompanied by a list of aphides recorded from other parts of the world on the corresponding plants. Three species are described as new.

Remedial measures are discussed on pages 91 and 92.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	<i>President</i>	
DIRECTOR CHARLES D. WOODS,	<i>Secretary</i>	
CHARLES L. JONES, Corinna,	}	<i>Committee of Board of Trustees</i>
FREELAND JONES, Bangor,		
WILLIAM A. MARTIN, Houlton		
JOHN A. ROBERTS, Norway		
EUGENE H. LIBBY, Auburn,	<i>Commissioner of Agriculture</i>	
ROBERT H. GARDINER, Gardiner,	<i>State Grange</i>	
RUTILLUS ALDEN, Winthrop,	<i>State Pomological Society</i>	
WILLIAM H. DAVIS, Augusta, <i>Maine Livestock Breeders' Association</i>	<i>State Dairymen's Association</i>	
WILLIAM G. HUNTON, Readfield,		

Maine Seed Improvement Association

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS, AND THE
DEAN OF THE COLLEGE OF AGRICULTURE.

THE STATION STAFF.

<i>ADMINISTRATION</i>	CHARLES D WOODS, Sc. D.,	<i>Director</i>
	BLANCHE F. POOLER,	<i>Clerk</i>
	GEM M. COOMBS,	<i>Stenographer</i>
	JANIE LOGIE FAYLE,	<i>Stenographer</i>
<i>BIOLOGY</i>	RAYMOND PEARL, PH. D.,	<i>Biologist</i>
	MAYNIE R. CURTIS, A. M.,	<i>Assistant</i>
	CLARENCE W. BARBER, B. S.,	<i>Assistant</i>
	FRANK TENNEY,	<i>Poultryman</i>
	HAZEL F. MARINER,	<i>Computer</i>
<i>CHEMISTRY</i>	JAMES M. BARTLETT, M. S.,	<i>Chemist</i>
	HERMAN H. HANSON, M. S.,	<i>Associate</i>
	EDWARD E. SAWYER, B. S.,	<i>Assistant</i>
	HELEN W. AVERILL, B. S.,	<i>Assistant</i>
	ELMER R. TOBEY, B. S.,	<i>Assistant</i>
	HARRY C. ALEXANDER,	<i>Laboratory Assistant</i>
<i>ENTOMOLOGY</i>	EDITH M. PATCH, PH. D.,	<i>Entomologist</i>
	ALICE W. AVERILL,	<i>Laboratory Assistant</i>
<i>PLANT PATHOLOGY</i>	WARNER J. MORSE, PH. D.,	<i>Pathologist</i>
	CHARLES E. LEWIS, PH. D.,	<i>Associate</i>
	MICHAEL SHAPOVALOV, B. A.,	<i>Assistant</i>
	VERNON FOLSOM,	<i>Laboratory Assistant</i>
<i>HIGHMOOR FARM</i>	WELLINGTON SINCLAIR,	<i>Superintendent</i>
ROYDEN L. HAMMOND,	<i>Seed Analyst and Photographer</i>	
CHARLES S. INMAN,	<i>Assistant</i>	

BULLETIN No. 213.

APHID PESTS OF MAINE. PART II.*

EDITH M. PATCH.

WILLOW FAMILY.

It is interesting to note that the aphides attacking willows and poplars are restricted to comparatively few genera. Many of the species are troublesome on shade and ornamental trees. The complete life cycle of certain gall forming species of the poplar is not yet known, but with *Pemphigus betae* (Gillette 1912) traced to the cottonwood for its winter host we have a stimulus for ascertaining whether the poplar serves as alternate host for other species of economic importance to vegetation outside of the willow family itself.

Pemphigus populimonilis Riley. The galls of this species are so familiar and characteristic with their bead like rows of cells each containing a single occupant, that *populimonilis* has been free from synonymic difficulties. Fig. 47.

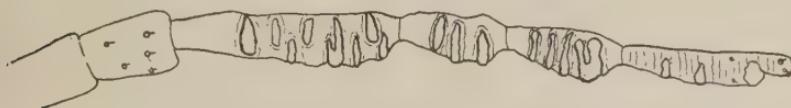


Fig. 20. *P. populimonilis*. Antenna of spring migrant.

Fig. 21. Antenna of pupa drawn to same scale as Fig. 20.

* Papers from the Maine Agricultural Experiment Station: Entomology No. 65.

Alate viviparous female,—*Spring migrant*. From late July until mid-August this form can be found winged and solitary in the gall which it is now ready to desert. Fig. 20 shows the antenna of this form and Fig. 46 D. the wing. Fig. 21 is a drawing of the antenna of the pupa, the joints IV and V of which are typically rather short and bulging, and VI longer, narrower and with nearly parallel margins.

Apterous viviparous female,—*Stem mother*. This form has not previously been recorded. I first took it in 1905 and have met with it since though the galls of the progeny so far outnumber those of the stem mother that many occur to one containing the apterous parent. Sometimes the stem mother is present in one of a chain of galls containing pupae, but often she is found in a single gall separate from those occurring in a chain but not differing from them in structure or appearance,—at least there is not enough difference so that those containing the stem mother can readily be separated without examining the insect itself.

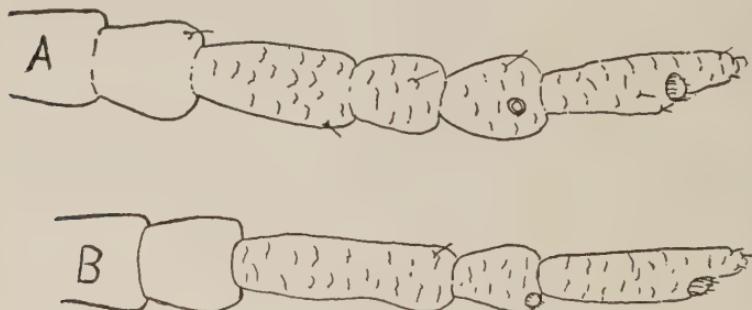


Fig. 22. *P. populinonis*. Antenna of stem-mother.

The antenna of this form (Fig. 22) is ordinarily 6-jointed though sometimes, as is often the case with stem mothers of allied species, there is some irregularity in the development of the antenna and it appears with 5 joints. The joints have the same rotundity as in the pupa, a character accentuated by the shortness of IV and V which are literally about as broad as they are long.

Collection data for this species are as follows: 46-05. *Populus balsamifera*. Aug. 15, 1905. Veazie, Me. Several stem mothers taken singly in galls but these were dead either from

parasitic insect or fungous attack. Winged form and pupæ were present in other galls, and a species of *Chaitophorus* was populating galls deserted by this *Pemphigus*.

86-06. *Populus balsamifera*. July 26, 1906. Veazie, Me. A single winged specimen in each small gall except where the gall was already vacated or occupied by a syrphus maggot.

81-09. *Populus balsamifera*. July 22-27, 1909. Veazie, Me. Galls very numerous. A single leaf was found bearing 65 galls. Four stem mothers, numerous pupæ and winged migrants still in galls,—each solitary.

99-12. *Populus balsamifera*. July 18, 1912. Veazie, Me. Galls numerous each containing a single insect in pupal stage.

Pemphigus gravicornis n. sp. For the past three years the pseudo-galls of this species have been common on *Populus balsamifera*. The affected leaves are folded lengthwise along the midrib and their margins are applied together at their ventral surfaces. The whole leaf except at the margin is swollen into a large sac or pocket which is filled with aphides. Fig. 53. This gall resembles that of *populiconduplifolii* but the two aphides are readily separated on antennal characters. So far as my observations go the galls of *gravicornis* occur on leaves anywhere on the tree while those of *populiconduplifolii* are on terminal leaves only.

Winged viviparous form.—*Spring migrant*, with antennal joints III, IV, V heavily charged with large irregular sensoria giving them a knurled appearance; and VI very slender and ordinarily without sensoria except the usual one at base of spur, though one or more others may be present. Fig. 23.



Fig. 23. *P. gravicornis*. Antennæ of spring migrant.

The wings are delicate and the veins faint. Fig. 46 H. No description has been made of the living specimens, but the peculiar antennæ will serve to distinguish this species.

Collection data are as follows:

87-06 July 26, 1906. Veazie, Me.; 26-11 July 7, 1911, Orono, Me.; 98-12 July 18, 1912, Veazie, Me. Pupæ and migrants

were taken but no stem mothers in these collections. The deserted galls are frequently appropriated by colonies of *Chaitophorus*.

Pemphigus populinconduplifolius Cowen. The galls of this species resembles that of *gravicornis* closely. Fig. 52. Sometimes galls of this species instead of being folded along the midrib are all on one side of the midrib in which case they are elevated above the level of the surface, and like those of *gravicornis* the ventral surface of the leaves forms the inside of the gall. Galls are pale green tinged with red and have a swollen appearance. The terminal leaves are those ordinarily attacked.

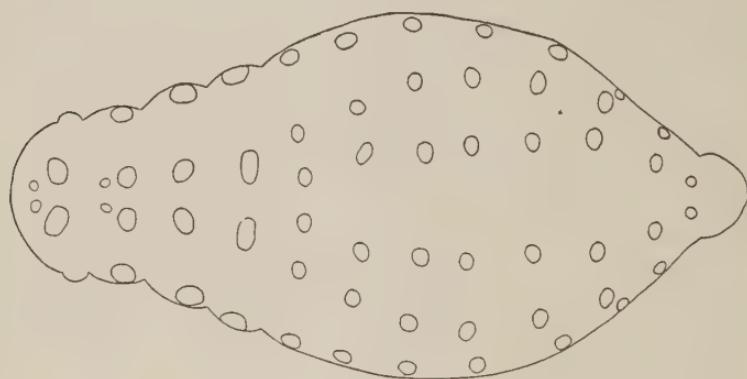


Fig. 24. *P. populinconduplifolius*. Wax gland areas of stem-mother.

Apterous viviparous female,—Stem mother. The wax gland areas of this form are shown in Fig. 24 and the antenna in Fig. 26. This insect is globular, dark greenish blue and woolly.

Winged viviparous form,—spring migrant. The antenna of this form is shown in Fig. 25 and the wing in Fig. 46 c.

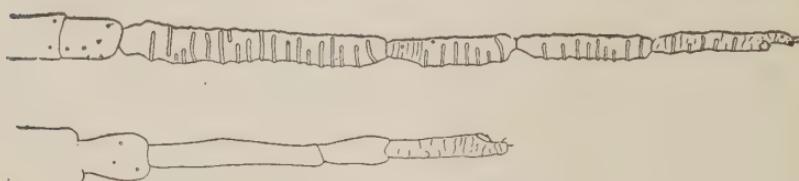


Fig. 25. *P. populinconduplifolius*. Antenna of spring migrant.

Fig. 26. Antenna of stem-mother.

Collection data are as follows:—23-06 (in part) June 14, 1906. Stem mothers; 37-10 June 29, 1910, Veazie, Me. Pupæ numerous and some migrants just winging; 46-10, 47-10, July 5, 1910, Veazie. One stem mother and numerous pupæ and winged forms. 91-12, a single stem mother in each gall with several nymphs, Orono Campus. 110-12, July 15, 1912, Orono, same tree as 91-12 and probably some of the same lot. Winged forms numerous. *Populus balsamifera*.

Pemphigus populicaulis Fitch. This species is structurally very close to *bursarius*. A few of the galls are shown in Figs. 49, 50, and 51. As will be noticed these are formed near the midrib and may be at the base of the leaf or elsewhere along the midrib, the opening being sometimes on the ventral (Fig. 49) and sometimes on the dorsal surface (Fig. 51). The galls vary considerably in size and in shape though they are more or less globular. This species is common on *Populus balsamifera* in this vicinity.

Winged viviparous female,—spring migrant. The wing of this form is shown in Fig. 46 I. and the antenna in Fig. 27. It will be noticed that joint VI is as heavily annulated as the other joints. I have specimens from Minnesota and Texas which accord with the Maine material and the figures of California specimens (Essig 1912) show the same characters as typical.



Fig. 27. *P. populicaulis*. Antenna of spring migrant.

Collection data are as follows:—23-11, Orono, July 6, 1911. Winged forms in galls.

101-12, July 18, 1912, Veazie. Galls on stem at base of leaf (Fig. 50) causing a twist in the stem. Opening on the ventral side. Galls are more or less pinkish and some are decidedly reddish.

102-12 Veazie, July 18, 1912, galls on ventral side of leaf opening on dorsal surface, greenish or occasionally pinkish. They measured from half an inch to three-quarters of an inch along the mid-rib. Fig. 51.

103-12, Veazie, July 18, 1912. Pinkish galls along the midrib on the dorsal side opening on the ventral surface. Fig. 49.

Pemphigus bursarius Linn? A species closely allied to, if not identical with *bursarius* of Europe (Tullgren 1909) is common on poplar here. The life cycle is not ascertained but breeding tests for an alternate host are planned. The antenna and wing are represented by figures 28 and 46 B.



Fig. 28. *P. bursarius*. Antenna of spring migrant.

The gall is found on the petiole of the leaf in the form of irregular swellings of varied size, anywhere from near the base of the leaf to the extreme proximal end of the petiole. Gall causes curve in the petiole or sometimes a confused twist where two or three galls are crowded close together. Galls are also sometimes found on the new growth twig itself. The opening is a rather lip like slit usually transverse to the petiole. Fig. 48.

Collection data are as follows:—

60-06, and 65-10, July 7 and 10, 1906. Irregular globular galls on petiole containing winged forms and pupæ.

64-06, July 10, 1906. Irregular globular galls on new growth twigs of *Populus*.

28-11, Orono Campus. *Populus deltoides* Marsh (var. Carolina poplar) July 12, 1911. Galls contained stem mother, small nymphs, pupæ and winged migrants.

Chaitophorus populincola Thomas. This well marked species does not seem to be confused with other American species either in our literature or collections. Common in Maine on Cottonwood, American Aspen (*P. tremuloides*) and Balsam Poplar (*P. balsamifera*).

Alate viviparous form. General color a varnished black. Antenna black with III paler. Sensoria as shown in figure 29. Abdomen black, hirsute with cornicles yellow. Wing veins black and heavily shadowed, shadow broader at tip of veins especially with the two discoidals where it broadens to a dark V. Fig. 46 K.

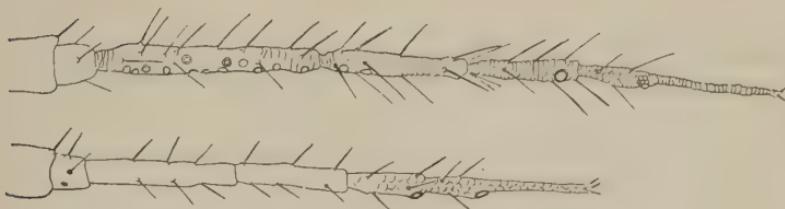
Fig. 29. *C. populincola*. Antenna of alate female.

Fig. 30. Antenna of apterous female.

Apterous viviparous form. Head and antenna black with III pale. Abdomen black dorsally and highly polished, ventral side paler and brownish. Cornicles light almost white. The progeny of these are reddish brown with a distinct yellowish λ , the stem of which extends to front of head, the fork coming on the abdomen and being much more distinct than the stem. Another yellow spot at caudal part of abdomen, and cornicles are very pale. Body mottled with black specks. Antenna brownish with III pale. Fig. 30. Legs brown.

Collection data as follows:—

47-04, Orono, June 23, 1904. Dark apterous females and nymphs on Aspen Poplar.

47-05, Veazie, Aug. 15, 1905. Balsam Poplar.

33-06, June 18, 1906. Both winged and apterous viviparous females on Balsam Poplar.

59-06, July 3, 1906. Both apterous and winged viviparous females and pupæ on Aspen Poplar.

93-06, August 3, 1906. Both apterous and winged viviparous females on Aspen Poplar.

13-08, June 19, 1908, Veazie. Winged and apterous viviparous females, pupæ and nymphs on leaves and tender shoots of Balsam Poplar.

39-08, Veazie, July 10, 1908. Winged viviparous females and nymphs on leaves and tender shoots of Balsam Poplar.

40-10, Veazie, June 29, 1910. Winged viviparous female and her progeny on ventral side of Balsam Poplar leaf.

41-10, Veazie, June 29, 1910. Winged and apterous females and nymphs on Aspen Poplar.

56-10, Orono, July 12, 1910. Winged and apterous females and nymphs on Balsam Poplar.

70-10, Veazie, July 21, 1910. On leaves and petioles. Apterous females very dark,—some entirely black except for a yellow mark on cephalic portion of abdomen and whitish yellow cornicles,—others yellowish brown as usual. Newly dropped nymphs orange yellow. Winged forms also present.

71-10, Veazie, July 21, 1910. On leaves and petioles of Aspen Poplar. Alate females and small dark apterous females.

5-11, Orono, July 14, 1911. On petioles and new growth twigs of cottonwood. Alate viviparous female.

96-12, Veazie, July 18, 1912. Apterous and alate females, on Balsam Poplar leaves and also in galls of *Pemphigus gravicornis*.

Chaitophorus delicata n. sp. A tiny species which I had not seen before and which appears to be undescribed was collected from the leaf of Aspen Poplar (*P. tremuloides*) by Mr. William C. Woods last summer.

The apterous females, nymphs and pupæ, were all a pellucid water white with a vivid green mark on prothorax, a transverse green stripe on first abdominal segment, and a green blotch in the region of the white cornicles more or less connecting them. Fig. 31 shows the relative length of the antennal joints.



Fig. 31. *C. delicata*. Antenna of apterous female.

No winged forms were obtained.

Collection data as follows:—

104-12, Veazie, July 18, 1912. Leaf of Aspen Poplar. A small collection of apterous females, nymphs and pupæ.

119-12, Orono, July 29, 1912. A small collection from ventral leaf of Aspen Poplar. Apterous females, nymphs and one pupa.

Chaitophorus viminalis Monell? Until the life cycle of this species with careful detailed descriptions of the successive generations has been worked out by some one I refrain from definitely attributing Maine collections to either *viminalis* or *nigrac* as at present I am too much confused to contribute any aid to the situation. What I take to be *viminalis* has two successive generations of apterous forms which are so different

in appearance that they might easily be mistaken for two distinct species and it would not be strange if this aphid has already been described under several names.

My color notes on collection 30-06, Veazie, June 15, 1906, *Salix* may be of interest in this connection. The apterous viviparous female had dorsal surface blackish with single well defined yellowish green streak extending from front of head to style,—streak very narrow through head but broadening in the central surface of body to an ovate space, narrowing again toward tip of abdomen. Cornicles yellow, style yellowish green, whole ventral surface greenish yellow. The apterous aphides that the form just described give birth to are uniform pale yellowish green with two vivid green longitudinal lines on the abdomen.

The alate viviparous females of this species present at the same date (June 15) have head and thorax black and abdomen black with greenish yellow lateral margin, cornicles dark, ventral abdomen greenish yellow. The wing (Fig. 46 E) is uniformly smoky dark with slender brown veins and brown stigma. For antennæ see Figs. 32 and 33.

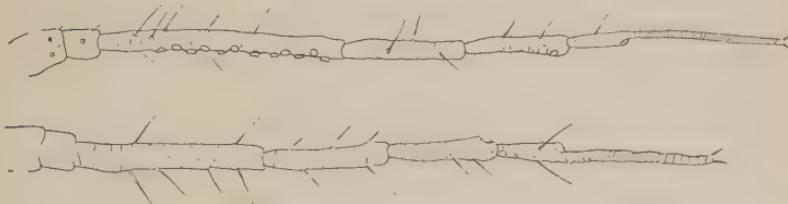


Fig. 32. *C. viminalis*. Antenna of alate female.

Fig. 33. Antenna of apterous female.

There are other species of *Chaitophorus* on *Salix* in Maine but my notes are not sufficient to record.

Aphis salicicola Thomas, I have taken only twice. It is characterized by long cylindrical cornicles, a style proportionately long, and the short branch of Media (Fig. 46 L). The relative length of the antennal segments are shown in Fig. 34. Antennal III has a single row of about seven rather faint sensoria. Fig. 35 shows the cornicle drawn to the same scale as the antenna.

36-04. Apterous and alate viviparous females collected from *Salix*, Orono, June 14, 1904.

88-12. Apterous viviparous females, *Salix*, Orono, July 16, 1912.



Fig. 34. *A. salicicola*. Antenna of alate female.

Fig. 35. Cornicle of same.

Aphis populifoliae Davis. Speckled Poplar Aphid. This remarkable species found usually on the upper surface of poplar leaves was described by Mr. Davis under the name of *Aphis populifoliae* (Fitch) in June, Econ. Ent. Vol. 3, 1910, p. 489.

The alate viviparous female has the following characters. Head black; no frontal tubercles; antenna with from about 20 to 30 sensoria on III, and few or none on IV relative length of joints shown in Fig. 36; eyes black; beak black, extends to between 2nd and 3rd coxae; prothorax black, lateral tubercles prominent; shape and venation of wings as usual for *Macrosiphum*, Fig. 46 G, veins and stigma black; legs with femora black, tibiae pale proximal 2-3 and black distal 1-3, tarsi black; abdomen black or reddish black with snow white pulverulent spots on dorsum arranged in transverse rows of one row per segment, venter slightly powdered; cornicles long cylindrical slightly swollen near base and black; style ensiform and upturned.

The apterous viviparous female is in general appearance black spotted with white. Head black, antenna (Fig. 38) black except proximal III which is very pale; sensoria present on III; eyes black; prothorax black with 2 white dorsal dots, tubercles present; thorax brownish black; legs with femora mostly dark proximally pale, tibiae mostly pale, distally dark, tarsi black; abdomen brownish black with white pulverulent spots and venter pulverulent; cornicles long, black, cylindrical, slightly swollen near base. Fig. 39 shows cornicle drawn to the same scale as Fig. 38.

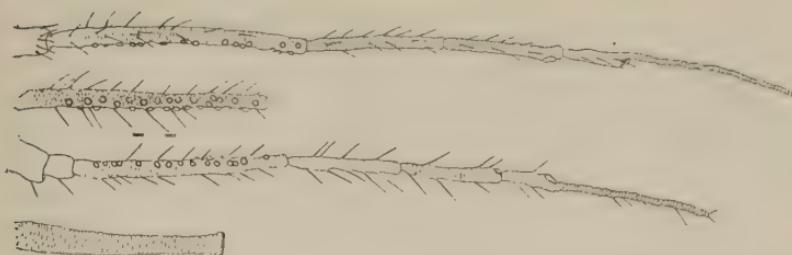


Fig. 36. *A. populifoliae*. Antenna of alate female. Fig. 37. Joint III of same from another individual. Fig. 38. Antenna of apterous female. Fig. 39. Cornicle of same.

Habitat of this species on new growth twigs but especially on dorsal surface of leaves causing a slight longitudinal curl upward. Found on *Populus balsamifera*, *P. tremuloides*, and certain other species of *Populus*.

Collection data: 58-06. One apterous viviparous female with progeny on dorsal leaf. Two alate viviparous females with progeny on dorsal leaves. *Populus balsamifera* and *P. tremuloides* July 3, 1906.

20-08. Apterous viviparous females and progeny. *Populus* sp. Orono, June 22, 1908.

36-08. A mass of this black and white species with a black and white larva of a lady beetle made one of the prettiest "coloration" schemes I have ever seen. *Populus* sp. terminal leaves and tender shoots. Orono, July 9, 1908.

70-08. Winged viviparous female and pupæ on balsam poplar (tender growth of water sprout). Orono, Aug. 25, 1908.

58-10. Apterous viviparous females and progeny on dorsal surface of leaves of *Populus balsamifera* causing a very slight upward curl of leaf. Orono, river bank, July 12, 1910.

77-10. Apterous and alate viviparous females, nymphs and pupæ on *P. balsamifera* on dorsal surface of leaves causing slight curl upward. Orono, river bank, July 23, 1910.

95-12. Apterous and alate viviparous females and nymphs on dorsal surface of leaves of balsam poplar turning the edges of edge and more or less crumple. Also present in galls of *Pemphigus gravicornis*, Veazie Sand Bank, July 18, 1912.

106-12. Alate and apterous viviparous females and nymphs

on dorsal surface of leaves of balsam poplar turning the edges slightly upward. Veazie, July 18, 1912.

Macrosiphum laevigatae Essig. In 1910 a colony of *Macrosiphum* was collected on the campus here at Orono since described from California as *laevigatae*. They were found on the ventral side of the tender tip leaves of willows at the rear of campus heating plant. Only apterous viviparous females and nymphs were taken that season, collection 78-10, but July 16, 1912, winged forms were found on *Salix* at Orono, collection 87-12.

The apterous viviparous female has a light greenish yellow head; antennæ (Fig. 40) with I, II, and III except articulation pale, and IV-VI black, III with 3 to 5 inconspicuous sensoria near base; eyes black, thorax, abdomen almost white with greenish yellow tinge and with a vivid green longitudinal line extending from prothorax to the fifth or sixth segment of abdomen where it sometimes stops abruptly; cornicles longer than antennal III, concolorous at base and dusky at tip which is distinctly though irregularly reticulated for a distance equaling about one-ninth the length of cornicle, the basal eight-ninths being comparatively smooth (Fig. 42); style concolorous with abdomen. There is a minute lateral abdominal tubercle just cephalad the base of the cornicle.

The winged viviparous female has about 10 delicate sensoria on basal half of antennal III. Fig. 41, drawn to the same scale as Fig. 42.

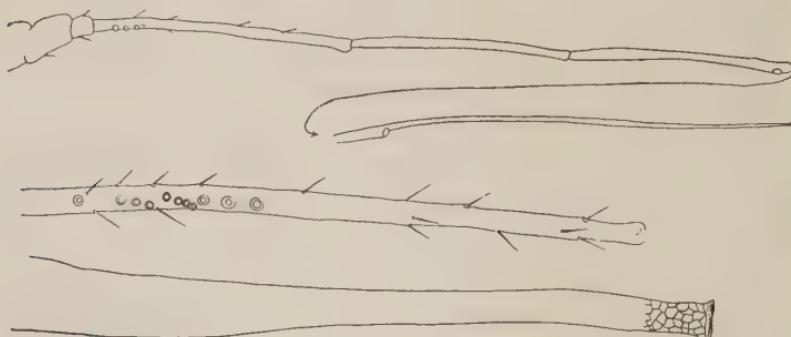


Fig. 40. *M. laevigatae*. Antenna of apterous female. Fig. 41. Joint III of antenna of alate female. Fig. 42. Cornicle of apterous female.

Melanoxantherium bicolor Oestlund. A species which I take to be *bicolor* is not uncommon here on Balsam Poplar.

Apterous viviparous female. Head reddish brown. Eyes black. Antenna with proximal part dingy yellow and distal part black. Spur much longer than basal VI. Prothorax and thorax reddish brown, lateral tubercles prominent. Fig. 44 A. Legs with femora dingy yellow and tibiae and tarsi black. Abdomen dark mottled reddish brown with pale inconspicuous median dorsal line, lateral tubercles prominent. Cornicles light dingy yellow like femora and longer and more slender than in *smithiae*. (51-10). Pupa colored like the apterous female.

Alate viviparous female. Head reddish brown. Antenna (Fig. 43) with spur much longer than basal VI. Prothorax reddish brown, lateral tubercles prominent, Fig. 44 A. Thorax reddish brown. Wings with pale slender veins and light brown stigma. Legs with brownish yellow femora and tibiae tipped with black, tarsi black. Abdomen reddish brown, cornicles light, dull brownish yellow. Fig. 45 A. Only a slight indication of a median dorsal line toward tip of abdomen. The young progeny of this form have a median grayish dorsal line the whole length of the body. (34-06).

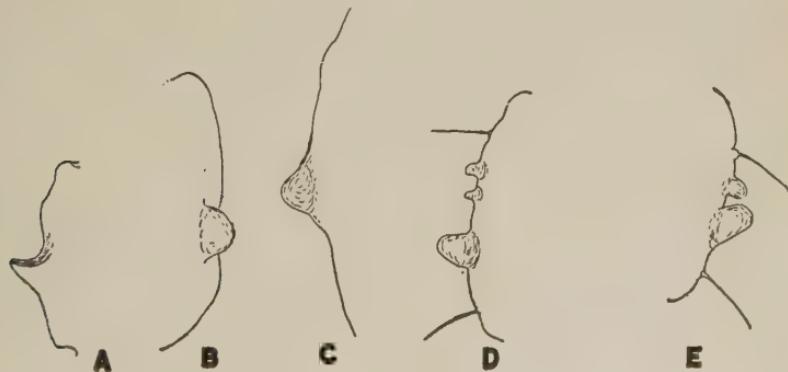


Fig. 44. *Melanoxantherium*. Prothoracic tubercles all drawn to the same scale. A, *bicolor*, apterous viviparous; B, *saliciti*, alate viviparous; C, *smithiae*, alate viviparous; D and E, *salicis*, apterous viviparous.

Collection data:—4-04 (in part). Orono, May 26, 1904. Winged specimens of both this species and *smithiae* were fairly abundant resting on the upper side of cultivated currant leaves.

They had probably merely alighted there as a resting place as no nymphs were present. The currants were not adjacent to willows, though willows were not far distant.

34-06, Veazie, June 19, 1906. Winged form on *Populus balsamifera*.

51-10, Veazie, July 7, 1910. Balsam Poplar. Apterous and alate females and pupæ.

Melanoxantherium salicti Harris. A species which I have taken for *salicti* was collected in Maine on willow in 1906. Head slaty black, not glistening, antenna black except at base. III with about 22 sensoria irregularly placed (Fig. 43, B.). Eyes black. Prothorax black, lateral tubercles present. Fig. 44, B. Thorax black with scutel lobe brownish, wings hyaline with pale brown veins and stigma the color of veins, legs with femora bright yellow, tibiae yellowish with dark distal tip, tarsi black. Abdomen black with bright yellow cornicles which are shaped much as in the foregoing species. (Fig. 45 B).

Predominating color slate-black with orange yellow legs and cornicles. There is the faintest suggestion of a light mid-dorsal line. (25-06). Orono, June 16, 1906. Willow twig.

Nymphs (half grown progeny of foregoing). Predominating color dark reddish brown with conspicuous median dorsal line of grayish white extending from front of head to cauda. Ventral surface slightly powdery gray. Antenna light, clear, with distal end dark. Legs with femora light clear, slightly yellowish, tibiae dusky, and tarsi black. Cornicles yellow. 26-06. Orono, June 16, 1906. Willow twig.

Melanoxantherium smithiae Monell. A dusky reddish species with hyaline wings, and pale pulverulent longitudinal median line on abdomen, cornicles orange, shorter and more bulging than in the three species preceding, accords with named specimens of *smithiae* kindly given me by Mr. Monell. Figs. 43 C, 44 C and 45C, D. On *Populus*, migrating to *Salix* early in June.

Collection data for this species are as follows:

4-04 (in part). Mixed collection of *bicolor* and *smithiae*. Winged forms resting on cultivated currant (probably alighted there temporarily only). Twelve taken in one hour. No progeny present. May 26, 1904. Orono.

15-04. Winged females. Willow. May 26, 1904, Orono.

66-04 and 67-04. Heavy infestation of winged and apterous females on willow in front of Experiment Station Building Sept. 9, 1904. This species proved such an annoyance to people using the building that the willows were removed.

6-07. Specimens received from Caribou, Maine, June 17, 1907, with the complaint that "they cover a limb and suck the bark until it is dead and peels off." On Carolina Poplars and Aspen trees.

64-10. Apterous viviparous females and nymphs on *Salix*, near Campus Greenhouse, new growth twig, Orono, July 18-25, 1910.

95-10. Apterous viviparous females and nymphs numerous along *Salix* stem. Orono, Aug. 18, 1910.

126-10. Winged and apterous viviparous females numerous on same willows from which 64-10 were collected. Sept. 15, 1910.

26-13. Orono *Populus*. June 2, 1913. Pupæ, and migrants ready for flight.

35-13. Orono, June 5, 1913. *Salix*. Migrants occurring singly with young.

Melanoxantherium antennatum n. sp. This remarkable species I have not met since 1908, and only the apterous oviparous females were seen at that time. However, this form is so distinctive it seems unnecessary to wait longer for the winged forms before presenting a brief description.

The apterous oviparous female has a blackish head with black eyes; antenna blackish and with but 4 joints, III with single terminal circular sensorium; (Fig. 43 D) prothorax greenish brown; tubercle lacking or inconspicuous; entire leg black; abdomen hirsute; incrassate clavate cornicles black upon a yellow spot; (Fig. 45 E) dorsal surface of body with a general dark greenish brown coat or blackish; ventral surface greenish yellow. Ventro-lateral margin of abdomen with the appearance of a longitudinal roll.

103-08. Apterous oviparous females and eggs received from E. No. Yarmouth, Maine, Oct. 31, 1908, with the statement "we find a great many of these insects on and in a pump which stands beneath an old willow."

104-08. Apterous oviparous females received from Cherryfield, Maine, Nov. 4, 1908.

Melanoxantherium salicis Linn. This black bodied aphid with conspicuous white spots, brilliant cornicles and heavily veined wings is a striking contrast to the allied but more subdued species of this genus.

Alate viviparous female. Head blackish; antenna (Fig. 43 E) with I, II, III brown, others blackish, III with about 14 sensoria in irregular row, base and spur of VI subequal; eyes black; prothorax blackish with prominent lateral tubercle; thorax with lobes all uniform black; wings with very heavy black veins, anal vein heaviest; legs with femora and tibiæ brown with points dark, tarsi black; abdomen greenish or brownish black with white median line composed of dots and with 4 white spots cephalad the cornicles in a row bordered by smaller ones and a large white spot at base caudad of cornicle; cornicles brilliant orange, long large bulging and with very little flare at opening, about as in the apterous form.

The young progeny of the alate viviparous females are dull greenish with bright orange cornicles and white markings arranged as in the parent.

Apterous viviparous female. The antenna (Fig. 43 F) with sensoria on III, but fewer than in the alate form. The cornicles are bright orange, long, large, bulging, constricted at tip with a very slight flare. (Fig. 45 F). The lateral tubercles of prothorax and abdomen are very large and conspicuous. In Maine collections the number and arrangement of those on the prothorax seem subject to variation. There is always one large prominent one but one or two others may be present. (Fig. 44 D and 44 E).

Collection data: 49-06. June 28, 1906. Alate viviparous females and nymphs on *Salix* along branches more than 1-4 inch in diameter.

8-08, Orono, June 16, 1908, on trunks and branches of *Salix* in gregarious colonies.

12-10. May 16, 1910. Gregarious along stem of *Salix*, Orono. Apterous viviparous females just mature not yet with progeny. Body black, cornicles bright orange.

16-10. May 18, 1910. Nymphs. First instar with 4-jointed antennæ and beak reaching beyond tip of abdomen. Second instar with 4-jointed antenna and beak extending beyond 3rd coxa. Third instar with 5-jointed antenna. June 6, winged

forms rapidly developing from colonies near base of main willow trunk.

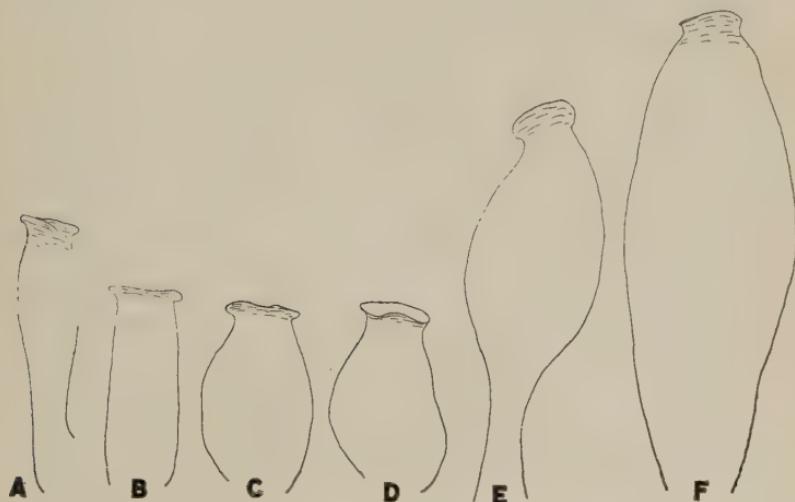


Fig. 45. *Melanoxantherium* cornicles all drawn to the same scale.
A, *bicolor*, alate viviparous; B, *salicti*, alate viviparous; C and D,
smithiae, alate and apterous viviparous; E, *antennatum* apterous
oviparous; F, *salicis* apterous viviparous.

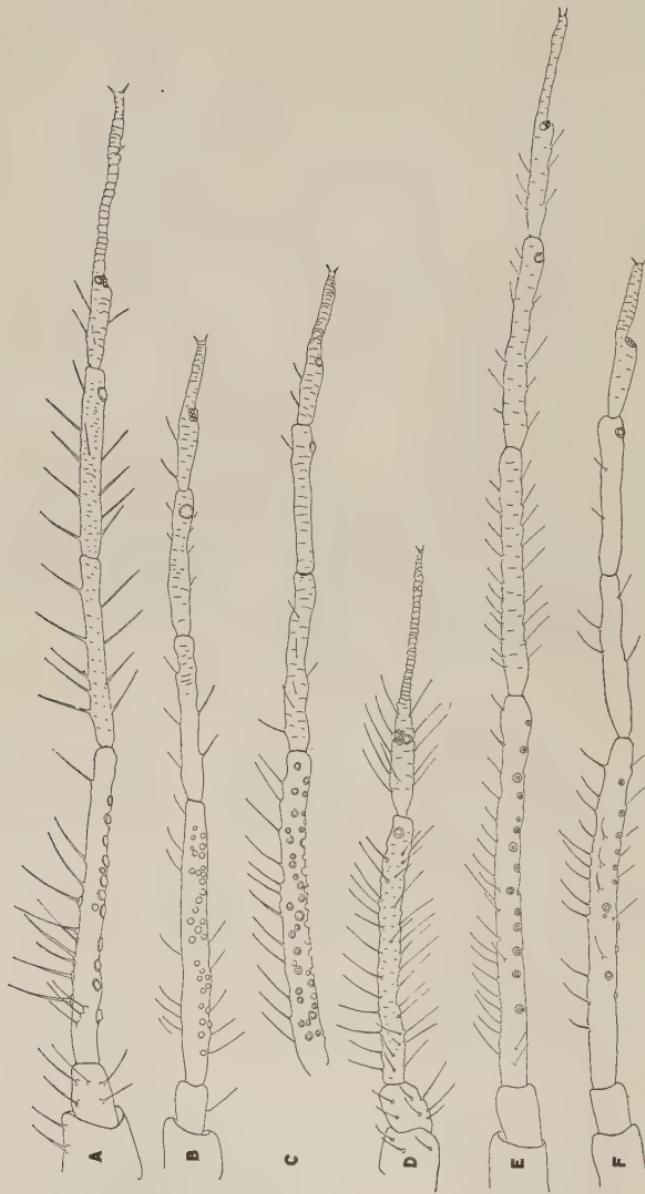


Fig. 43. Antennæ of *Melanoxanthemum*, all drawn to the same scale. A, *bicolor*, alate viviparous; B, *salicis*, alate viviparous; C, *smithiae*, alate viviparous; D, *antennatum*, apterous oviparous; E, *sulcifrons*, alate viviparous; F, *salicis*, apterous viviparous.

APHID CONTROL.

Shade or ornamental trees can be protected frequently from serious aphid attacks by keeping watch from year to year. This is especially desirable while trees are young. Later it is more difficult, but the damage is not usually as serious on large well established trees.

From small or isolated trees the galls of gall forming species can sometimes be collected by hand before the aphides leave them, thus lessening the trouble in that vicinity for another year.

Species inhabiting the trunk of large branches can be destroyed in great numbers by using a brush dipped in any of the spray solutions ordinarily used for aphides.

Tips of branches bearing leaves which have been curled by aphides can be dipped into a tobacco decoction long enough for the solution to penetrate. Such a method as this is of course only applicable for a few treasured plants or small trees.

In recent years tobacco extracts have rapidly taken the place of other sprays for aphides, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying

Formula—Tobacco Decoction.

Tobacco stems or tobacco dust..... 2 pounds.

Water 4 gallons.

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco *while cooking*. Apply at once or within a few days after making, if possible.

Certain reliable extracts such as "*Black Leaf*," "*Black Leaf 40*," and "*Nikoteen*" are on the market and can be secured through local drug-gists. The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company*, Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by *The Nicotine Manufacturing Company*, St. Louis, Mo., and can be secured from *Joseph Brick & Sons*, 47-54 N. Market St., Boston, Mass.

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in proportion of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 700 or 800 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of a thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to "wet" and "stick" to the bodies of the aphids. For this purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

When other plant enemies besides aphids are present "Combination sprays" are frequently successfully applied. Self-boiled lime-sulphur (8-8-50 cold) may be used adding 1-70 of its volume of *Black Leaf*. On the same basis *Black Leaf* may be combined with Bordeaux (5-5-50) or with lead arsenate or with both together when foes combine against one kind of plant.

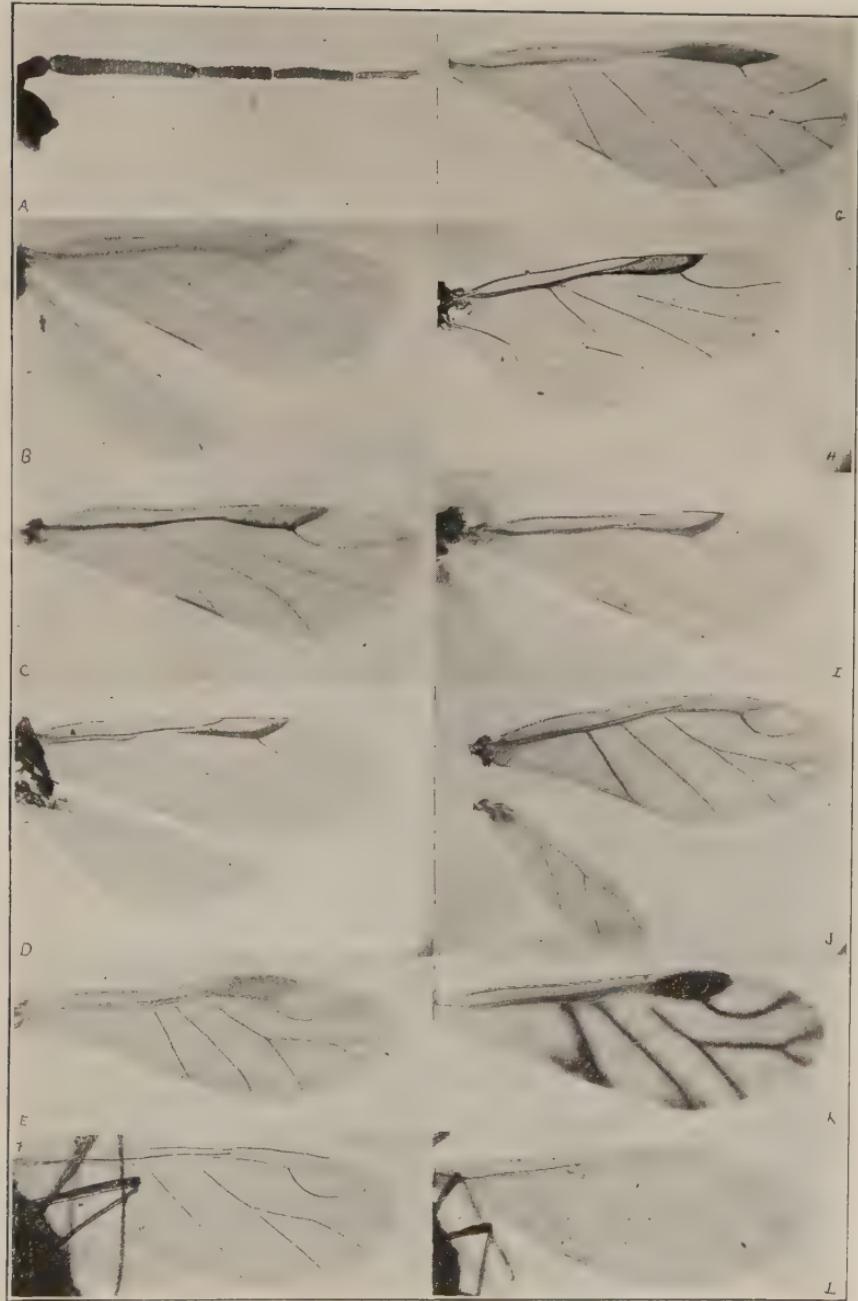


Fig. 46. A, *Pemphigus gravicornis*; B, *P. bursarius*; C, *P. conduplifolius*; D, *P. populimonilis*; E, *C. viminalis*? G, *Mac. laevigatae*; F, *Aphis dorsalis*; H, *P. gravicornis*; I, *P. populicaulis*; J, *Melanoxantherium salicis*; K, *C. populicola*; L, *A. salicicola*.



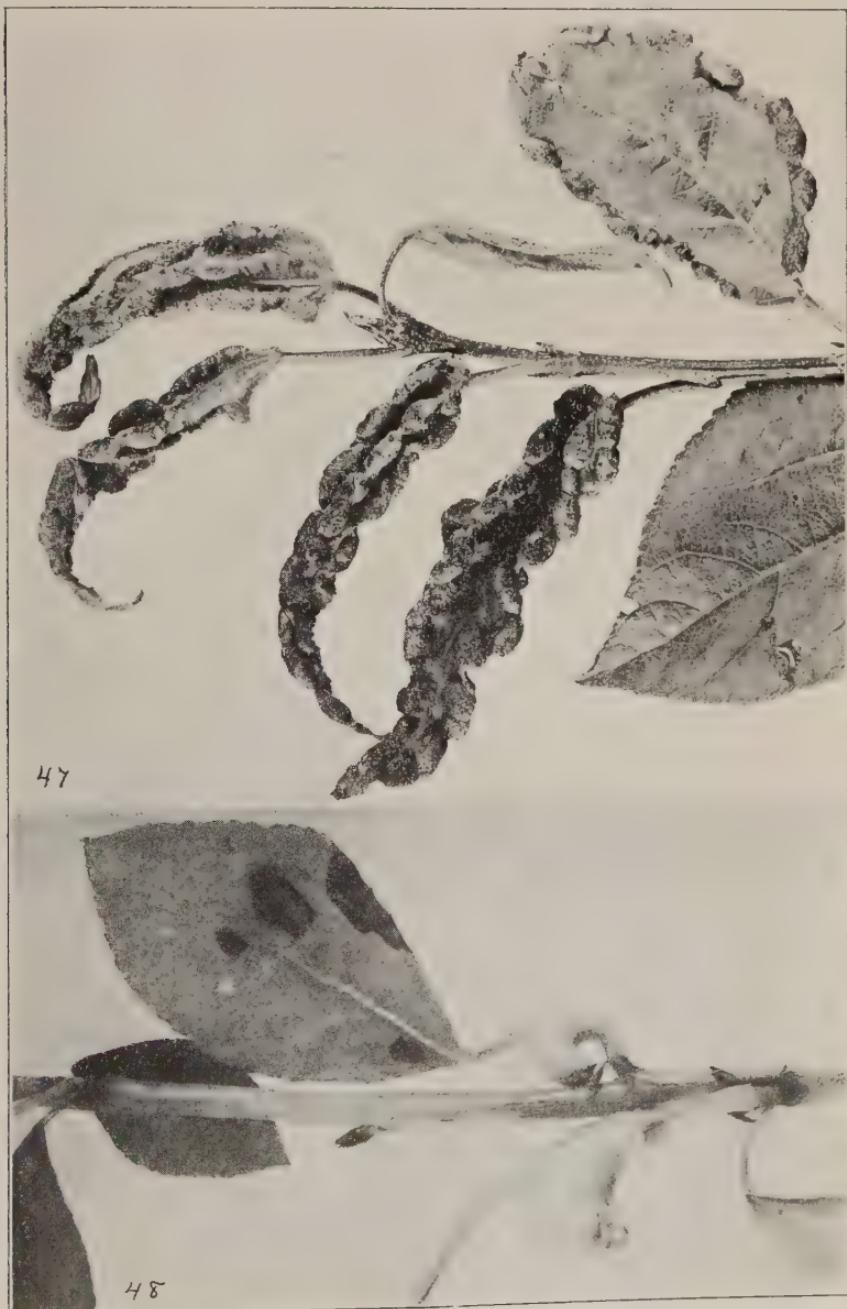
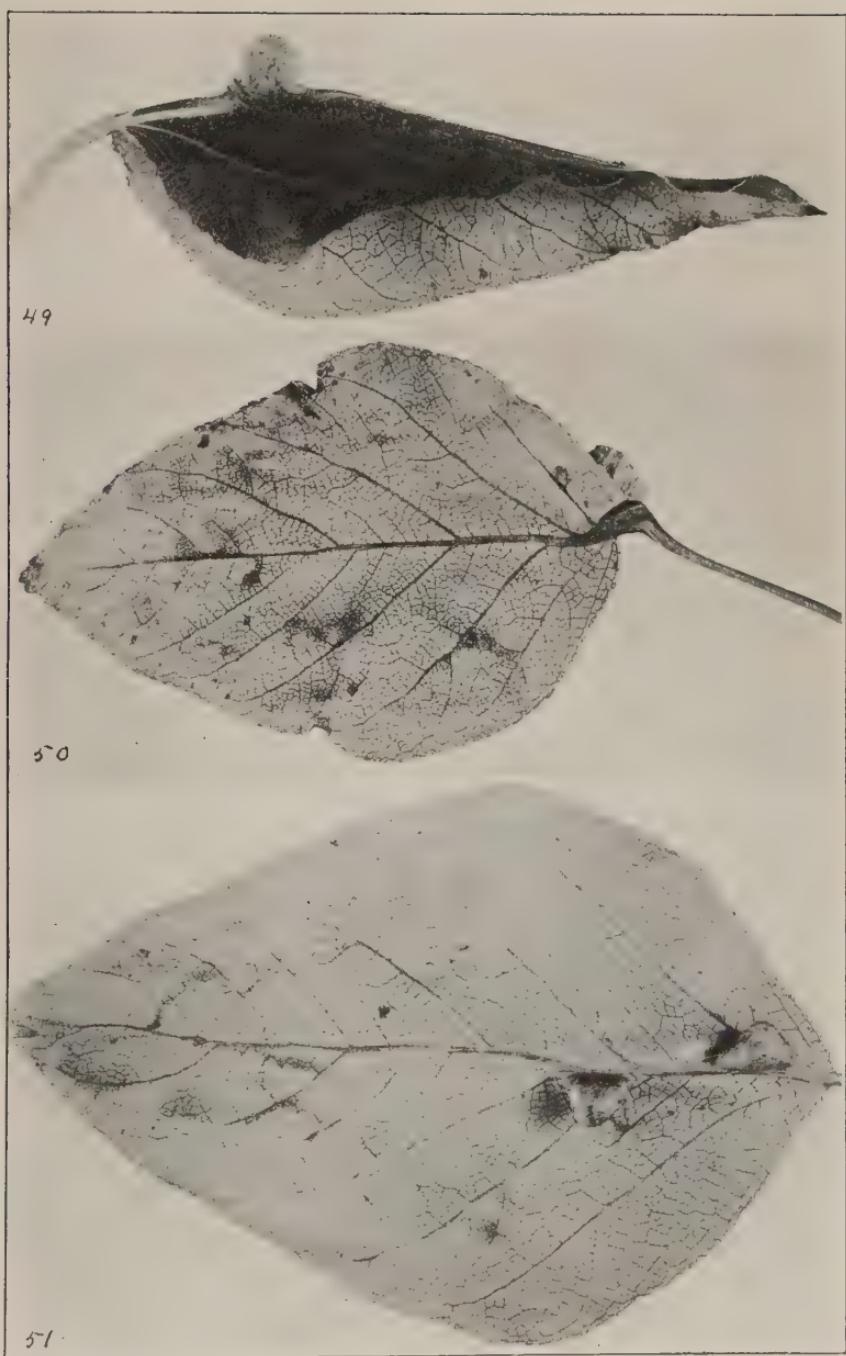


Fig. 47. *P. populinilis*. Galls collected at Veazie, Maine, July 27, 1909.
Fig. 48. *P. bursarius*. Galls collected at Orono, July 12, 1911.



Figs. 49-51. Galls of *Pemphigus populicaulis*.

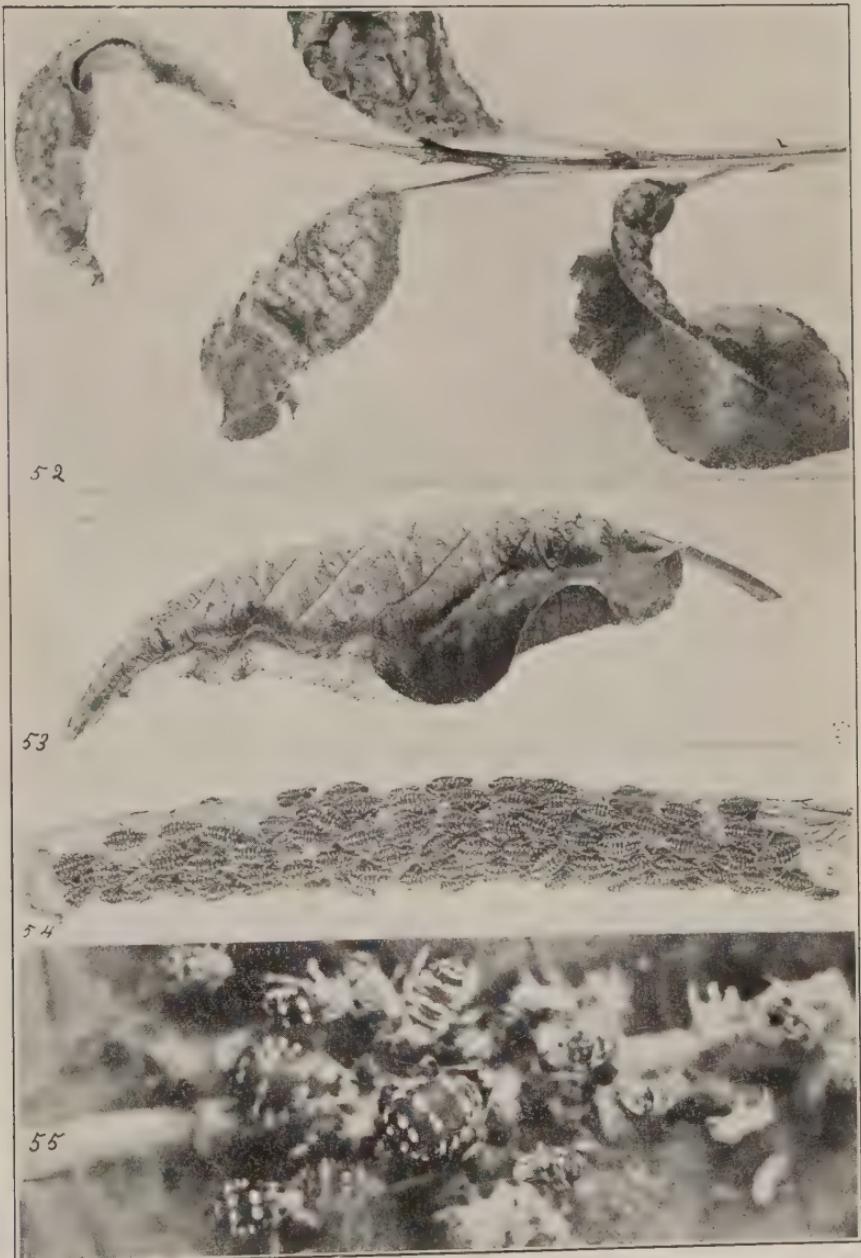


Fig. 52. *P. populiconduplifolius*. Galls collected at Orono, July 15, 1912.
Fig. 53. *P. gravicornis*. Galls collected at Orono, July 7, 1911.

Fig. 54. *Melanoxantherium salicis*. Collection made at Orono, May 16, 1910.
Fig. 55. *Aphis populifoliae*. Collection made at Veazie, July 18, 1912.

FOOD PLANT CATALOGUE OF THE APHIDAE OF THE
WORLD.

PART II.*

EDITH M. PATCH.

SALICACEAE. WILLOW FAMILY.

POPULUS. Poplar. Aspen.

P. alba L. (*canescens*). White Poplar, Silver-leaved Poplar.

Chaitophorus populi (Linn.) Pass. (*Myzaegirus Amyot*),
(*Arctaphis populi* Walker). Buckton, 2, p. 142.

Cladobius populae Kalt. (*Aphis*) Macchiati, 1883, p. 260.

Guercioja populi Del Guercio. Mordwilko, 1908, p. 361 (9).

Lachnus longirostris Fab? Passerini, 1860, p. 38.

Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.

Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.

Pachypappa vesicalis Koch. Cholodkovsky, 1901, p. 293.

Schizoneura tremulae DeGeer. Kaltenbach, 1874, p. 561.

P. angustifolia James (*laevigata*).

Chaitophorus populicola Thomas. Hunter, 1901, p. 88.

Pemphigus populi-monilis Riley. Cowen, 1895, p. 116.

P. balsamifera L. Balsam Poplar, Tacamahac (1911).

Aphis populifoliae Davis, 1910. Patch, 1913, Bul. 213, p. 82.

Chaitophorus populicola Thomas. Patch, 1913, Bul. 213, p. 78.

Mclanoxantherium bicolor Oestlund. Patch, 1913, Bul. 213, p. 85.

Pemphigus balsamiferae Williams. Williams, 1910 (1911), p. 8.

Pemphigus gravicornis Patch. Patch, 1913, Bul. 213, p. 75.

Pemphigus popularius Fitch. Jackson, 1908, p. 191.

Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.

Pemphigus populiconduplicifolius Cowen. Gillette, 1909a, p. 355.
Patch, 1913, Bul. 213, p. 76.

Pemphigus populiglobuli Fitch. Jackson, 1908, p. 197.

Pemphigus populimonilis Riley. Essig, 1912, p. 707. Patch, 1913,
Bul. 213, p. 73.

Pemphigus populiramulorum Riley. Jackson, 1908, p. 209.

Pemphigus populitransversus Riley. Jackson, 1908, p. 207.

Pemphigus populivenae Fitch. Jackson, 1908, p. 195.

Stagona vesicalis Rudow. Rudow, 1875, p. 249.

* Papers from the Maine Agricultural Experiment Station: Entomology No. 66. For Part I see Bulletin 202.

P. berolinensis.

Pemphigus bursarius L. (*lactucarius* Pass) (*pyriformis* Licht.)
Tullgren, 1909, p. 122.

P. canadensis.

Pemphigus filaginis Boyer. (*gnaphalii* Kalt) (*prociphilus gnaphalii* Koch) (*Pachypappa marsupialis* Koch) (*ovato-oblongus* Kessel). Tullgren, 1909, p. 136.

P. candicans Ait. Balm-of-Gilead.

Aphis candicans Fitch. Monell, 1879, p. 26.

Chaitophorus candicans Thomas. Hunter, 1901, p. 87.

Melanoxanthus salicis Linn. Cowen, 1895, p. 117.

P. deltoides Marsh. (*monilifera*) (*angulata*) Cotton-wood, Necklace-Poplar.

Arctaphis sp. Cooley, 1912, p. 89. "New *Aphis* of Cottonwoods."

Chaitophorus populicola Thomas. 1879, p. 104.

Chaitophorus populifolia Fitch (*stevensis* Sanborn). Sanborn, 1904, p. 36 and 1906, p. 225.

Chaitophorus populifoliae (Fitch). Hunter, 1901, p. 88.

Melanoxantherium salicti Harris. Weed, 1891, p. 290.

Pemphigus betae Doane. Gillette, 1912, (24th Rept. Exp. Sta.) p. 28. "On Cottonwood."

Pemphigus bursarius Linn? Patch, 1913, Bul. 213, p. 78.

Pemphigus oestlundii Cockerell, 1906, p. 34.

Pemphigus populicaulis Fitch. Sanborn, 1904, p. 20.

Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.

Pemphigus populiconduplifolius Coweni. Jackson, 1908, p. 217.

Pemphigus populitransversus Riley. Sanborn, 1904, p. 22.

Pemphigus populitransversus Riley. Jackson, 1908, p. 207.

Pemphigus pseudobyrsa Walsh. Jackson, 1908, p. 199.

Phylloxera popularia Pergande. Pergande, 1904b, p. 266.

(In galls of *Pemphigus transversus* Riley).

Phylloxera prolifera Oestlund. Oestlund, 1887, p. 17. (In galls of *Pemphigus populicaulis* Fitch).

P. Fremonti S. Wats.

Chaitophorus populicola Thomas. Williams, 1891, p. 9.

Melanoxanthus salicti (Harris). Williams, 1891, p. 9.

Mordwilkoja oestlundii (Cockerell) (*Pemphigus vagabundus* Walsh) Davis, 1911, p. 4.

Pemphigus populicaulis Fitch. Williams, 1891, p. 9.

Pemphigus populimonilis Riley. Davidson, 1910, p. 374.

Pemphigus populiramulorum Riley. Jackson, 1908, p. 209.

Pemphigus populitransversus Riley. Williams, 1891, p. 9.

Pemphigus pseudobyrsa (Walsh). Williams, 1891, p. 9.

Phylloxera prolifera Oestlund. Williams, 1891, p. 9.

Thomasia populifoliae (Fitch). Essig, 1912a, p. 716.

P. grandidentata Michx. Large-toothed Aspen.

Aphis populifoliae Fitch. Thomas, 1879, p. 102.

Aphis (Dactynus) populus-grandidentata Raf. Rafinesque, 1818.

Chaitophorus populi (Linn). Hunter, 1901, p. 88.

Chaitophorus populifoliae (Fitch) " = *C. populi* (Linn.) ?" Oestlund, 1887, p. 39.

P. nigra L. Black Poplar.

Anuraphis populi Del Guercio. Del Guercio, 1909 (1910). Redia VII, p. 298.

Aphis populi L. Kaltenbach, 1874, p. 561.

Chaitophorus leucomelas Koch. Passerini, 1863, p. 58.

Chaitophorus leucomelas Koch, Pass. Buckton, 2, p. 135.

Chaitophorus lyratus Ferrari. Del Guercio, 1900, p. 119.

Chaitophorus nassonowi Mordwilko. Mordwilko, 1899, p. 410.

Chaitophorus populi (Linn) Pass. (*Myzaegirus Amyot*) (*Arctaphis populi* Walker). Buckton, 2, p. 142.

Chaitophorus versicolor Koch (*Aphis populi* var. *Kalt*) Ferrari, 1872, p. 76.

Lachnus viminalis Boyer. (*Aphis*). Ferrari, 1872, p. 80.

Pemphigus affinis Kalt. (*Thecabius populneus* Koch). Passerini, 1863, p. 74.

Pemphigus bursarius (L.) Kalt. Kaltenbach, 1874, p. 561.

Pemphigus bursarius Hartig. (*Eriosoma populi* Mosley) (*Aphioides bursaria* Rondani). Buckton, 3, p. 118.

Pemphigus flaginisi Boyer (*gnaphalii* Kalt.) (*Prociphilus gnaphalii* Koch) (*Pachypappa marsupialis* Koch). (ovato-oblongus Kessler). Tullgren, 1909, p. 136.

Pemphigus spirothecae Koch (*affinis* Koch) (Puceron de peuplier Reaumur). Buckton, 3, p. 122.

Pemphigus spyrothecae Pass. Passerini, 1860, p. 39.

Pemphigus tortuosus Rudow. Rudow, 1875, p. 248.

Pemphigus vesicarius Pass. Passerini, 1863, p. 76.

Stomaphis bobretzkyi Mordwilko. Mordwilko, 1899, p. 411.

Stomaphis longirostris (Fab.). Del Guercio, 1907 (1908) Redia V, p. 344.

Thecabius populneus Koch. Koch, p. 295.

Thecabius populneus Koch. Kaltenbach, 1874, p. 562.

P. pyramidalis Salisb. (*italica* Duroi) (*dilatata*). Lombardy Poplar.

Chaitophorus leucomelas Koch. Kessler, 1882, p. 37.

Chaitophorus nassonowi Mordwilko. Mordwilko, 1899, p. 410.

Chaitophorus populeus (Kalt.) (*Lachnus punctatus* Burm?) (*Cladobius populeus* Koch). Buckton, 2, p. 137.

Chaitophorus populi (Linn). Pass. (*Myzaegirus Amyot*) (*Arctaphis populi* Walker). Buckton, 2, p. 142.

Cladobius populea Kalt. (*Aphis*) Ferrari, 1872, p. 76.

Drepanosiphum smaragdinum Koch. Koch, p. 205.

Drepanosiphum (*Aphis*) *tiliae* Koch. Kaltenbach, 1874, p. 561.

Pemphigus affinis Kalt. Kaltenbach, 1874, p. 561.

Pemphigus bursarius Linn. Reaum (Aphis). Ferrari, 1872, p. 83.

Pemphigus bursarius Hartig (*Eriosoma populi* Mosley) (*Aphioides bursaria* Rondani). Buckton, 3, p. 118.

Pemphigus filaginis Boy de Fonsc. (gnaphalii Kalt.) (Proctophilus gnaphalii Koch.) (Pachypappa marsupialis Koch) (ovato-oblongus Kessler). Tullgren, 1909, p. 136.

Pemphigus glandiformis Rudow. Rudow, 1875, p. 247.

Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.

Pemphigus protospirae Licht. Tullgren, 1909, p. 155.

Pemphigus spirothecae Pass. (affinis Koch). Tullgren, 1909, p. 161.

P. tremula L.

Aphis populi tremulae Ascanius. Hagen, p. 449.

Asiphum populi (Fab.) Koch. Koch, p. 246.

Asiphum tremulae DG. Tullgren, 1909, p. 66.

Chaitophorus populi (Linn.) Pass. (Myzaegirus Amyot) (Arctaphis populi Walker). Buckton, 2, p. 142.

Chaitophorus populi (Linn.) (Ch. tremulae Koch). Koch, p. 9.

Chaitophorus versicolor Koch. Passerini Flora.

Pachypappa lactea Tull. Tullgren, 1909, p. 72.

P. tremuloides Michx. (trepida). American aspen.

Aphis populifoliae Davis, 1910. Patch, 1913, Bul. 213, p. 82.

Aphis (Dactynus) populus-trepida Raf. Rafinesque, 1818.

Chaitophorus brunneri Williams. Williams, 1910, (1911), p. 26.

Chaitophorus delicata Patch. Patch, 1913, Bul. 213, p. 80.

Chaitophorus populicola Thomas. Gillette, 1909a, p. 388. Patch, 1913, Bul. 213, p. 78.

Cladobius beulahensis Cockerell. Cockerell, 1904, p. 263.

Pemphigus populicaulis Fitch. Hunter, 1901, p. 78.

Pemphigus? rileyi Stebbins. Stebbins, 1910, p. 9.

P. trichocarpa Torr. & Gray.

Chaitophorus populicola Thos. (?). Essig, 1909, p. 98.

Chaitophorus salicicola Essig. Essig, 1911b, p. 534.

Eichochoaitophorus populifolii Essig. Essig, 1912a, p. 715.

Pemphigus populicaulis Fitch. Essig, 1912a, p. 712.

Pemphigus populimonilis Riley. Gillette, 1909a, p. 356.

Pemphigus populitransversus Riley. Davidson, 1910, p. 372.

P. sp.

Aphis populi-albae Boyer. Lichtenstein, La Flore.

Byrsocrypta vagabunda Walsh. Walsh, 1862, p. 306. (migrants "on various forest trees").

Chaitophorus albus Mordwilko. Mordwilko, 1899 (1901), p. 410.

Chaitophorus populifoliae Fitch. Davidson, 1910, p. 375.

Cladobius longirostris Mordwilko. Mordwilko, 1899, (1901), p. 414.

Cladobius rufulus Davidson. Davidson, 1910, p. 375.

Lachnus longistigma Monell. Sanborn, 1904, p. 31.

Pemphigus borealis Tullgren. Tullgren, 1909, p. 146.

Pemphigus immunis Buckton. Buckton, 1896, p. 51.

Pemphigus infaustus Ferrari. Lichtenstein, 1885 ("var. de P. spirothecae Pass.").

- Pemphigus lichtensteini* Tull. Tullgren 1909, p. 151.
Pemphigus napaeus Buckton. Buckton, 1896, p. 50.
Pemphigus oestlundi Cockerell. (*P. vagabundus* (Walsh) of authors). Oestlund, 1887, p. 22. Cockerell, 1906, p. 34.
Pemphigus populi Courchet. Courchet, 1881, p. 46.
Pemphigus populicaulis Fitch (betae Doane?). Clarke, 1903, p. 248.
Pemphigus spiriformis Licht. Zoölogical Record, 1886, p. 319 (misprint for pyriformis).
Pemphigus tortuosus Rudow. Lichtenstein, La Flore.
Pemphigus varsoviensis Mordwilko. Mordwilko, 1899, p. 411.
Schizoneura passerinii Signoret. Lichtenstein, La Flore.
Schizoneura populi Gillette. Gillette, 1901, p. 1.
Thecabius (Pemphigus) affinis Kalt. (*ranaunculi* Kalt.). Tullgren, 1909, p. 110.

SALIX. Willow.

S. acuminata.

Lachnus viminalis (Boyer) Pass. (*salicis* Shaw?) (*salicis Curtis?*) (*saligna* Walker). Buckton, 3, p. 57.

S. alba L. (*vitellina*) White Willow.

Aphis populea Kalt. (*Lachnus punctatus* Burmeister). Kaltenbach, 1843, p. 117.

Aphis populea Kalt. Kaltenbach, 1874, p. 561.

Aphis salicis Linn. Kaltenbach, 1874, p. 586.

Chaitophorus saliceti Schrank (*Aphis*). Macchiati, 1883, p. 261.

Chaitophorus salicti Schrank (*Aphis*). Ferrari, 1872, p. 77.

Chaitophorus smitheae Monell. Monell, 1879, p. 32.

Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.

Chaitophorus vitellinae Schrank (*Aphis*). Ferrari, 1872, p. 76.

Cladobius populae Kalt (*Aphis*). Macchiati, 1883, p. 260.

Cladobius steinheili Mordwilko. Mordwilko, 1899, p. 350. (? on *Salix alba*).

Lachnus longirostris Fab? (*Aphis*). Ferrari, 1872, p. 81.

Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.

Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.

Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585. Del Guercio, 1907 (1908). *Redia* V, p. 345.

Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.

Melanoxanthus smithiae Monell. Williams, 1891, p. 27.

Myzus ribis Linn. et auct (*Aphis*). Ferrari, 1872, p. 62.

Siphocoryne capreae (Fab.) Pass. (*pastinacae* L.) (*A. aegopodii* Scop) (*R. capreae* Koch) (*R. cicutae* Koch) (*A. umbellatarum* Koch). Passerini, 1863, p. 52.

Stomaphis longirostris (Fab.) (*Aphis* Fab.) (*Phylloxera* Boyer) (*Lachnus Passerini*) Del Guercio, 1907 (1908) *Redia* V, pp. 259, 344.

S. amygdaloïdes Anders. Peach-leaved Willow.

Aphis salicicola (Thomas). Cowen, 1895, p. 121.

S. babylonica L. (*annularis*) Weeping Willow.

Aphis capreae Fab. (*A. aegopodii* Scop.). Kaltenbach, 1843, p. 109.

Aphis saliceti Kalt. Passerini, 1863, p. 37.

Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.

Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.

Rhopalosiphum salicis Monell. Monell, 1879, p. 27.

S. laevigata Bebb.

Chaitophorus salicicola Essig. Essig, 1911b, p. 534.

Fullawayia saliciradicis Essig. Essig, 1912a, p. 716.

Macrosiphum laevigatae Essig. Essig, 1911b, p. 549.

Micrella monelli Essig. Essig, 1912a, p. 715.

Symdobius salicicorticis Essig. Essig, 1912a, p. 715.

S. lapponum L.

Chaetophorus salicivorus Passerini. Schouteden, 1906a, p. 213.

S. lasiolepis Benth.

Micrella monelli Essig. Essig, 1912a, p. 715.

S. longifolia M. (interior) Sand Bar Willow.

Chaitophorus nigrae Oestlund. Cowen, 1895, p. 117.

Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.

S. lucida Muhl. Shining Willow.

Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.

Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.

Siphocoryne (Rhopalosiphum) salicis (Monell). Oestlund, 1887, p. 70.

S. macrostachya Nutt.

Symdobius macrostachyae Essig. Essig, 1912a, p. 715.

Thomasia crucis Essig. Essig, 1912a, p. 716.

S. nigra Marsh. Black Willow.

Chaitophorus nigrae Oestlund. Oestlund, 1887, p. 40.

Rhopalosiphum salicis Monell. Monell, 1879, p. 27.

S. nigricans Sm.

Chaitophorus capreae Koch. Buckton, 2, p. 136.

Chaitophorus salicti (Schrank) Pass. Passerini, 1863, p. 60.

Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.

S. purpurea L. Purple Willow.

Chaitophorus salicivora Walker? Passerini, 1860, p. 37.

Chaitophorus salicivora Pass. (*salicivora* Walker?) Passerini, 1863, p. 58.

Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585.

S. repens L.

Chaitophorus hypogaeus Del Guercio. Schouteden, 1906, p. 213.

S. caprea L.

Aphis alterna Walker. Walker, 1849c, p. 43.

Aphis capreae Fab. (*A. aegopodii* Scop.) Kaltenbach, 1843, p. 109.

Aphis populea Kalt. (*Lachnus punctatus* Burmeister). Kaltenbach, 1843, p. 117.

Aphis saliceti Kalt. Buckton, 2, p. 53.

Aphis salicis Linn. Kaltenbach, 1874, p. 586.

Aphis secunda Walker. Walker, 1849c, p. 44.

Chaitophorus capreae Koch. Buckton, 2, p. 137.

Chaitophorus salicivorus (Walker) Pass. Buckton, 2, p. 135.

Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585. Del Guercio 1907 (1908) *Redia* V, p. 345.

S. cinerea L.

Aphis saliceti Kalt. Del Guercio, 1909 (1910) *Redia* VII, p. 297.

Chaetophorus salicivorus Passerini. Schouteden, 1906a, p. 213.

Chaetophorus salicti Schrank. Schouteden, 1906a, p. 213.

Lachnus viminalis (Boyer) (*Aphis saligna* Sulzer, Walker, p. 959). (*A. salicina* Zett.) (*A. salicis* Curtis) (*Lachnus dentatus* Le Baron) Del Guercio, 1907 (1908) *Redia* V, p. 345.

Melanoxantherium sp. Schouteden, 1906a, p. 215.

S. cordata Muhl.

Chaitophorus cordatae Williams. Williams, 1910 (1911), p. 27.

Chaitophorus viminalis Monell. Williams, 1910 (1911), p. 30.

S. daphnooides Vill.

Lachnus viminalis (Boyer) Pass. (*salicis* Shaw?) (*salicis* Curtis?) (*saligna* Walker). Buckton, 3, p. 57.

S. discolor Muhl. Glaucous Willow.

Aphis (Siphonophora) salicicola (Thomas) Monell. Oestlund, 1887, p. 63.

S. fragilis L. (*Russelliana*). Crack Willow.

Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.

Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585.

S. glaucophylla.

Chaitophorus n. sp. Sanborn. Sanborn, 1904, p. 34.

S. speciosa.

Aphis spectabilis Ferrari. Ferrari, 1872, p. 64.

S. triandra L.

Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.

S. viminalis L. Osier.

Aphis saliceti Kalt. Ferrari, 1872, p. 64. Del Guercio, *Redia* VIII, p. 297.

Aphis salicti Kalt. Theobald, 1911-12.

Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.

Lachnus longirostris Fab.? (*Aphis*). Ferrari, 1872, p. 81.

Lachnus viminalis (Boyer) Pass. (*A. saligna* Walker?). Passerini, 1869, p. 64. (*dentatus* Le Baron) Del Guercio, 1907 (1908), *Redia* V, pp. 281, 345.

Melanoxanthus salicis (Linn.). Buckton, 2, p. 23.

S. vitellina L.

Aphis populea Kalt. Kaltenbach, 1874, p. 561.

Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.

Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.

Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.

S. sp.

Aphis amenticola Kalt. Kaltenbach, 1874, p. 586.

Aphis cicutae Koch. (*capreae* Fab.) Kaltenbach, 1874, p. 585.

Aphis gracilis Walker. Walker, 1852, p. 1040.

Aphis saliceti Kalt. Kaltenbach, 1874, p. 585.

Aphis saliceti Schrank. Kaltenbach, 1874, p. 586.

Aphis salicicola (Thomas) Monell (A. *brevifurca* Monell MSS) Monell, 1879, p. 24.

Aphis salicicola Thomas. Gillette, 1910, p. 403.

Aphis salicina Zetterstedt. (*Chaitophorus?*) Tullgren, 1909, p. 6.

Aphis pilosa Haldeman (A. *salicis?*) Hunter, 1901, p. 102.

Aphis spectabilis Ferrari (? *amenticola* Kaltenbach). Schouteden, 1906a, p. 228.

Aphis truncata Hausmann. Lichtenstein, La Flore.

Chaitophorus populeus (Kalt.) (*Lachnus punctatus* Burm?) Buckton, 2, p. 139.

Chaitophorus salicicola Monell. (*Lachnus salicicola* Uhler?) Thomas, 1879, p. 105.

Chaitophorus salicis Williams. Williams, 1891, p. 27.

Chaitophorus viminalis Monell. Patch, 1913, Bul. 213, p. 80.

Chaitophorus sp. Davidson, 1909, p. 301.

Cladobius rufulus Davidson. Davidson, 1909, p. 300.

Lachnus dentatus Le Baron. Weed, 1890, p. 117.

Lachnus salicellis Fitch (L. *salicicola* Harris?). Thomas, 1879, p. 119.

Lachnus saligna Walker. Lichtenstein, La Flore.

Lachnus viminalis (Boyer) (L. *dentatus* Le Baron). Oestlund, 1887, p. 32.

Macrosiphum laevigatae Essig. Patch, 1913, Bul. 213, p. 84.

Melanoxantherium antennatum Patch. Patch, 1913, Bul. 213, p. 84.

Melanoxanthus bicolor Oestlund. Weed, 1891, p. 290.

Melanoxantherium flocculosum (Weed). Gillette, 1909a, p. 385.

Melanoxantherium salicis (Linn.). Gillette, 1909a, p. 387; Patch, 1913, Bul. 213, p. 88.

Melanoxantherium salicti Harris. Patch, 1913, Bul. 213, p. 86.

Melanoxanthus salicis (Linn.). Weed, 1890, p. 115.

Melanoxanthus smithiae (Monell). Gillette, 1909a, p. 387; Patch, 1913, Bul. 213, p. 86.

Myzus achyrantes Monell. Sanborn, 1904, p. 71.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

Nectarophora californica Clarke. Clarke, 1903, p. 254.

Phylloxera salicicola Pergande. Pergande, 1904b, p. 269.

Phylloxerina salicis (Licht.) CB. Börner, 1909b, p. 60.

Pterocomma pilosa Buckton. Buckton, 2, p. 144.

Siphocoryne aegopodii Scopoli. Lichtenstein, La Flore.

Siphocoryne salicis Monell. Weed, 1893, p. 297.

Siphonophora salicicola Thomas. Thomas, 1879, p. 193.

